# Edge/Core Collaboration: Navigating the Ocean


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# EDGE / CORE COLLABORATION: NAVIGATING THE OCEAN


## Summary:

It would seem to a disinterested observer that the future of the telecom industry will be decided by the victory of one armed camp or another. There are the Edge service providers offering OTT services who see the Network service providers as mere bit-carriers, and therefore easily replaceable albeit at a cost. And there are the Network service providers who see little value in the Edge providers, who they consider to be dependent on getting a free ride over their networks. Neither of these opposing views is reasonable or accurate. The Edge brings creativity and a plethora of new revenue opportunities; the Network brings an immense asset investment, and a well-managed one. Both sides appear to see strategy as "us or them", where "them" is actually a potential source of business advantage if only we could find the right symbiotic way to make money together.


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It would seem to a disinterested observer that the future of the telecom industry will be decided by the victory of one armed camp or another: Edge vs. Core – but what if we could find the right symbiotic way to make money together?

## Sailing off the edge of the world?

*They are ill discoverers that think there is no land, when they can see nothing but sea. [Sir Francis Bacon]*

In the old days, the edge of the telecom network was just the analog black phone. In the POTS world the network owners were the service providers (SP). These national and regional companies planned and built the network and the edge. They knew their well-defined market boundary, for this was the boundary of their home territory. The call was the product. SPs controlled what edge devices were available since only their devices could connect to this network. They bought from their domestic equipment provider and software developer – indeed, like old Ma Bell, often all three divisions were in one corporation. Do you long for these simpler days? We do not.

As competition became national policy, the market divided into service providers, equipment manufacturers, and independent software vendors (ISV). Next came intelligent networks, digital networks, and some consumer product choice. But everything proceeded in an orderly fashion. Planning cycles were long and well managed.

Then came data networks and the internet, vendors began to specialize and their numbers exploded. Access was the service product while networks were the asset being built. The capacity of networks began to exponentially increase and specialized networks were built to service the many new protocols that were churned out by standards groups and industry associations. This was the communications industry's industrial age. But still, all was controlled in the executive clubs of the communications industrials where long term purchase and cooperation agreements and interwoven managements provided closed leadership to the telecom industry.

During this period of explosive growth during the nineties, a new strategy surfaced. It was not good enough to make money from calls and data connectivity. Explosive growth and explosive valuations required more revenue than could be pulled from these 'network-based products'. We remember the strategy as it was introduced to engineering at MCI in the mid-nineties: to survive we had to move up the value chain. This was seen as moving up the old DEC stack from network protocol and connectivity to the applications running on the computers connected to the network. We would do this by combining the "intelligent network" to the data networks. We all would move up the value added chain to *services*.

Then a decade ago David Isenberg, in The Rise of the Stupid Network spoke to the importance of the edge. He laid out his proposition that the network service providers soon would no longer control the future development of telecom networks. Instead, this power would increasingly shift to the edge. This was one of the first manifestos that suggested that the edge had value, although the argument did not impress many in the traditional service provider community. But what was the edge? There was not much there when Isenberg first spoke. While service providers were growing the networks, other industries connecting to data networks and the Internet soon discovered the values of connectivity and immediate collaboration for themselves. SP account teams sold the connectivity, but the customers understood the value proposition better than the sales people, because they knew how the connectivity would be used. The customers understood the potential of this new connected environment and began inventing new ways to use the shared network.

Innovation at the edge is continuing, creating novel ways to connect people, business and systems. New services just keep coming – faster than we can keep track. The result is that complexity is increasing dramatically both at the edge and in the patterns of connectivity this creates across the service provider networks. In fact, it is difficult to visualize the extent of this growth in complexity. New mathematical approaches are being developed to address this, for example the use of dandelion diagrams to chart the major nodes of the internet and the network domains reachable through them.

Dandelion diagrams while not fractal, explode outward as you follow them. Putting the diagram in motion as you traverse a branch, it looks like the flower seeds are continually folding outward - from any branch it blossoms into another seed cluster. These 3D diagrams, as complex as they are, are only tracing the physical structure of the internet. Diagramming the entirety of the logical connectivity and routing in the Internet involves a higher order of complexity; services and protocols are yet another layer to be overlaid on routing and connectivity diagrams.

## Navigating the Seas of Complexity

The edge of the telecom world is becoming increasingly complex, to the extent that we do not really understand just how complex it is. This means that while we must continue to increase our understanding of what is going on out there and build the mathematical tools to describe and analyze it, we should not be fooled into thinking that we can manage this complexity in anything like the way we used to manage traditional networks and services.

The traditional world of telecoms was like a collection of well-managed lakes connected by an orderly system of canals. The global network of today is more like an ocean.

*The ocean is a wilderness reaching round the globe, wilder than a Bengal jungle, and fuller of monsters, washing the very wharves of our cities* ... [Henry David Thoreau].

Some network service providers still aspire to manage this metaphorical ocean, in much the same way as they used to manage the lakes and canals in the old days. So, in most telecom planning and design activities, everyone continues to use two dimensional drawings for workflows and for decision analysis trees which, even with computer programs sketching and stretching them out for us, keeps the choices limited and the logic flows simple. But “the map is not the territory”: simplifying things because we cannot grasp the complexity is not really simplification, but rather a representation of our watered-down understanding. Our choices of what to select and what to pass over, in our efforts at simplification, may not be what is important. Indeed, our choices for simplification rarely match the true drivers of complex systems. Now that we are starting to build an understanding of complexity mathematics – this description of large complex systems with their hard-to-find *strange attractors* – we should realize that our management tools and our understanding of linear processes and logic flows just do not cut it, no matter how sophisticated they seem to be.

Should we really try to manage the ocean, to calm the winds and still the currents? Could it be that we might be better-employed building ships, charting currents, deploying navigation systems and building weather forecasting systems that can enable everyone to ride the rough seas safely?

## Finding Treasure at the Edge

Network/edge decoupling has created an environment that has expanded many times the potential for new and valuable ways to make use of network connectivity. In other words, the liberated edge can be blamed for all this complexity, but the explosion of innovation makes it all worth it. We just have to find some ways of coping in this rich new world.

Most sailors setting out upon a great ocean voyage expect to eventually reach land – not sail off the edge of the world. Explorers hope that the voyage will yield new riches. Today's edge is richer than we could have imagined just a few years ago (indeed richer than most of us can grasp today). We have space for only a few examples of the new markets that are springing up on the edge of the network and that thrive, we should all remember, only because the network is there to provide the connectivity the edge needs.

**Innovation from the Edge (OTT services)**: When we were younger we saw the cool gadgets of the TV cartoon animation *The Jetsons* - including a neat video phone. We waited and waited for the traditional service providers to build this enrichment to communication-at-a-distance, but it never happened. Certainly SPs tried, and each time failed. But today I have a video phone in my laptop and I can buy a video terminal in any consumer electronics store, ready to plug in to my broadband access. I have all the facility of the Jetsons and more. But no traditional SP built and marketed this service. Edge companies did: OTT VoIP companies and IM service providers working with consumer electronics companies.

"Service providers can create or host applications within their own network, however this is naturally constrained—the greatest breadth of application and content innovation will always fall outside any one network service provider. There will always be a wider range of applications and content off-net driven by content service providers like Google, Yahoo! And Microsoft or specialized providers and start-ups." [Chris Komatas, Director, Service Provider Marketing at Juniper.]

**Smart homes**: What is an intelligent neighborhood and smart home? Phil Johnston's company has helped design intelligent communities including one in Thousand Palms, CA with completely automated energy, automated lighting, security, entertainment, advanced learning and elderly person monitoring. Houses are connected to neighborhood systems delivering security, local retail, local activity groups, local learning facilities and other local services. Phil told us how the local telecom service provider is simply not needed for this development. The community laid its own GPON fiber network and built a local data center to provide all the community services, and struck its own interconnect deal.

Similarly, aiming at their next fortune, the Anasari family (of the near-space X-prize space race) have invested their capital and their management talents in a new enterprise aimed at linking smart homes and service providers. They are designing this alone without service provider partnerships. Perhaps, with a partnership, a sharing of insight and plans with a SP, their end product might be better. But they need a reason, an example, to see it that way. And the traditional service provider industry is not providing good references here.

**Smart retail & supply chain**: Retail stores in Germany have deployed web applications that help shoppers create their shopping lists, which are then downloaded to in-store smart shopping carts which guide customers around the store. Eventually these systems will interconnect with smart devices in smart homes to build shopping lists based on usage. This works because the internet portal, sales application, cart, and order-stocking programs, all are networked.

Indeed, there is a natural symmetry between the function of networks and the function of supply chains. Goods and services, to an extent, travel from supplier to receiver much likes packet are routed in the network. Further, a synergy exists between supply chains and networks. Information of place, time, and routing can be fed from automated package readers and smart dollies over the network to supply-chain applications. None of these applications needs a telecom service provider to host or support these complex integrated services, but every one needs a service provider to carry the bits.

**Expansion of wikis and knowledge bases**: Once, telecom made great profits by being the sole supplier of information to its users via "yellow pages" – phone directories organized by commercial service subject and providing space proportionate to advertising charges. Now this business has largely migrated

to the edge internet companies, although some phone companies persist in delivering big paper books that quickly end up in the recycling box. This new Edge based services are good for the consumer, but all that information on the edge of the network is now outside a service provider's revenue sphere.

Another example of the SPs being by-passed in the knowledge industry is the placement of the Library of congress image collection on line, a new use for another innovative OTT service. From the **Library of Congress Blog:** "… it is so exciting to let people know about the launch of a brand-new pilot project the Library of Congress is undertaking with **Flickr**, the enormously popular photo-sharing site that has been a Web 2.0 innovator.… the project will help address at least two major challenges: how to ensure better and better access to our collections, and how to ensure that we have the best possible information about those collections for the benefit of researchers and posterity. … The real magic comes when the power of the Flickr community takes over. We want people to tag, comment and make notes on the images, just like any other Flickr photo, which will benefit not only the community but also the collections themselves."

**Policy-driven, intelligent CPE**: An enterprise customer can now independently buy network connection hardware that builds their own VPN network and adjusts itself to optimally route packets. The point is to prioritize and route packet flows for the good of the edge applications, not for the efficiency of the service provider network. (Which is not necessarily how network service providers currently use policy-based VPNs.) Such devices can create and auto-negotiate their own overlay VPN – even using multiple provider networks.

People who use OTT VoIP services must have noticed how generally audio quality has improved steadily since the earlier days. Much of that improvement can be credited to edge intelligence: smarter and faster CODECs at the paying subscriber's edge, and digital signal processing implemented by the OTT service providers, not within the network core.

Once again we can see how edge smarts can reduce or eliminate reliance on the capabilities of the network to deliver valued services.

**Sensor and camera grids**: We have seen the importance of video surveillance networks in London and other major cities in areas like traffic management and public safety. Increasingly cities will turn to deployment of these network-connected devices. Breakthroughs are occurring in industrial sensors. Besides monitoring, they will be deployed in control systems requiring stringent network quality standards, for example municipal water systems and power systems.

Sensor networks are one part of *pervasive computing*, as are smart homes, and supply chain package readers. "The emergence of sensor networks consisting of large number of resource limited sensors, and ad hoc networks, in which wireless roaming devices result in continuing changes in network layout can be considered the backbone of future pervasive systems…. These complex and untraditional networks necessitate architectural approaches that facilitate context reasoning capabilities, which are also realistic in their ability of achieving them in large scales." [Carl Kesselman]

Soon we will be entering a period of explosive growth in deployment of intelligent network-connected devices. Before long there will be vast arrays of sensors feeding thousands of network computers in one global communications web. And traditional service providers will carry the bits.

## The Call of the Sea: The Edge Seeks Liberation and New Worlds

The above examples reinforce our understanding that the Edge can provide valuable services for customers, calling on network service providers only for fast and reliable connectivity. But are there

counter-examples out there that might suggest that network service providers can completely own their customers? How about mobile voice telephony for example?

At first the mobile phone seemed to be just a simple introduction of a new workstation that was associated with an individual (not a place) and moved with that individual. Service providers procured the handsets and resold them, built the access radio networks and provided core connectivity. But the edge devices turned out to be smarter than needed just to make voice phone calls. This added to the perceived value of the service, and maybe service providers did not fully appreciate the power they were unleashing with this (admittedly limited) uncoupling of the edge device from the network, and adding significant processing power to these edge devices. The very nature of the service and its wide popularity brought unforeseen new requirements such as regulation demanding number portability and near real-time provider network switching; service complexity increased and service providers discovered the need for a new range of management tools.

The success of mobile services meant that edge device manufacturers could produce mobile phones in very large numbers, transforming the cell phone - not just a network edge device, but now a consumer electronics product. Today the service providers and the telecom equipment providers are beginning to lose their tight control of the boundary between the native service facility of the phone and the other applications loaded on it. Some service providers now realize that they may end up not even controlling every aspect of how future consumer edge appliances use their networks. Then Apple, a company traditionally not in the telecom space, developed the iPhone – a consumer appliance – and went looking for networks for it to use. Amazon released a more specialist consumer appliance – the Kindle eBook reader – and bundled the wireless service with it.

We believe this trend will continue, as we already see service providers (Verizon and T-Mobile) moving in the direction of allowing more openness over their wireless networks. Far from viewing this as a sign of carrier demise, this is actually, in our opinion a good sign. **The evidence is, that in the quest to innovate and find new business opportunities, the Edge will seek, and find, liberation, one way or another.**

This is the ocean we find ourselves upon, and the one we must all learn to navigate safely.

## Setting Course: The Case for Collaboration

The above examples illustrate that to a large extent, the Edge can fulfill David Isenberg's prediction that carriers *need* do no more than deliver bits, reliably and predictably at a reasonable cost. But this prompts the question: is this the *best* way to do it?

Edge service providers have some reason to regard network service providers, with their talk of walled gardens, with suspicion. Equally network service providers publicly criticize companies who make money from Edge-delivered OTT services as looking for a free ride (although no one, as far as we know, gets to connect to the Internet for free).

The Edge is too rich and complex to simply "be a service". Capturing it in even the best product catalogue is an exercise in futility. So network service providers pick out a small part of the universe of services and edge customers (such as the Telco 2.0 and TMF push for collaboration with media) to partner with and everything else becomes a threat. "They must fight us to get what they need." And then the edge customer just figures out a way around the network provider; since they cannot live without the network that makes the Edge services possible.

The Edge is too impatient to slow down or stop to wait for network service providers to adapt to these natural changes. When a needed facility *is* provided by the network operators and their vendor support system, it is used – provided no less restrictive and/or less costly method is available. If the facility is not there or is too expensive, they will build it themselves. This is the market at work. The tremendous pace of change created by a liberated edge is not consistent with traditional service provider attitudes and business models. For them, this change is worrying. They fear a potential loss of control, but it's already happened.

*If everything seems under control, you're not going fast enough. [Mario Andretti.]*

Edge developers are rapidly creating new services, in effect competing with traditional service provider views of owning the customer and developing new services in an orderly fashion (see our October 2007 *NPI* and December 2007 *OTT service* articles).

Why?

- Because they can. An explosion has occurred in the facilities and tools (examples: AJAX, Parley, SIP) for easily creating services.
- Because service providers have not stepped up to this expanded plate – it is just too much scope and not enough capital
- Because service providers remain myopic – concentrating on the familiar and lamenting the way things were.

The present situation is clearly less than wonderful for Edge providers and Network service providers. So how should network service providers do business with this new intelligent edge? How should edge providers and network carriers work together to service pervasive device connectivity?

Network service providers, like all other commercial companies, are subject to continuous bottom line pressure from the financial markets and investors: their clear and simple directive is to reduce costs and increase revenue. Somehow this pressure is translated into just two bipolar strategic options for surviving and prospering in this new leaner world.

- The preferred option: Increase revenues by fighting the Edge providers, and become a valued-added service company, controlling all the services and endpoints connected to the network.
- The dismal option: Concede to the Edge service providers, slim down dramatically, become an efficient bit-carrier and charge for bandwidth and service specific QoS.

We believe there is a better option than either of these, which is:

- Nurture the Edge providers, because the Edge is where all the innovation and incremental revenues will come from. Understand the Edge, and find out what it needs, and then together find mutually acceptable ways of charging for fulfilling those needs.

The growth in richness and complexity of the Edge is enabled by the expansion of capabilities and reach of the network. **Edge and Network providers should seek symbiosis rather than engage in competitive exclusion games.**

## No One is an Island: What the Edge Needs from the Network

As members of the telecom ecosystem, service providers, equipment manufactures, independent software vendors, and systems integrators, we all must discover: *What does the Network have that the Edge really needs*?

We hear a lot about the two sided business model as described in Simon Torrance's Telco 2.0 project where the service provider receives payment from media companies to deliver content and bill users for it while still charging users for access. This was taken up by the TMF who did explore what the core – the service provider systems and management – could offer to the media industry. But we still find this a simplistic business model, and it ignores an enormous amount of new activity at the Edge that is outside the control of the traditional media companies. Morphologically this model is much the same as delivering call connectivity – but now between a media server and an edge customer.

**IC/UC**: Looked at from the perspective of the Edge service providers of IP interactive communications (IC) and unified communications(UC), we find a rather different perspective and set of imperatives than those expressed by our friendly neighborhood network service providers. The Edge perspective, as expressed by Seamus Hourihan, who coined the term "session border control", now with Acme Packet, as Vice President, Marketing & Product Management:

"IC and UC services and applications will only become valuable when we can use them to reach anyone, anywhere, anytime. To paraphrase Metcalfe's Law: *the usefulness, or utility, of interactive communication equals the square of the number of users.* Consequently, IC/UC must span multiple IP networks – business, residential and mobile; wireline, wireless and cable. Today's consumers and businesses will be satisfied with—and pay money for—nothing less. Our only options for delivering this network nirvana are the Internet or the Federnet - a federation of managed IP networks."

Building on Seamus' own analysis, the edge community is asking for these specific needs to be filled by network service providers, (and if not them, someone). The IC/UC community (and its developers) want the network to provide:

- Security: protection from malicious and incidental attacks such as unrestricted notifications. "Subscribers are not capable of protecting themselves from everything. They need and want to trust their service provider."
- Address and connectivity that work across all networks; address space mediation; plus the elimination of meaningless and inconsistent prefixes to numbers/addresses.
- SIP should be everywhere and consistently applied everywhere with the same architecture and extensions;
- Until universal SIP happens, networks should provide universal protocol mediation.
- Support of any CODECs, with QoS that is specifically tunable to the various endpoint CODECs.
- Transparent QoS selection where the underlying SP network mechanism is hidden.
- Policy-based call/connection/session prioritization. Overriding network rules (emergency first) than user's ability to pay for priority class interfaces.
- Selection from heterogeneous cost models such as "pay for what you select/get" of QoS.
- Creation of barrier free federated IP networks;
- Connection to anyone, anywhere, at anytime over any federated network connection.

- Clarification of the basic business model of who pays for what and why. (Well, perhaps this is asking too much – does it happen in any other industry?)

**Smart Homes**: What specifically does the intelligent neighborhood and its smart homes need from the networks and what network and service management services will be needed? According to Phil Johnson, he would be interested in network service providers bringing these services:

- "Higher speed access such as direct home-to-core network GPON connections.
- Hosted services for neighborhood and community servers.
- More community-based service management with servers and networks based on the community needs and requirements, such as elderly care with Telemedicine at home monitoring, local storage and ASP model services.

## Stewardship of the Seas: a role for BSS/OSS

Our analysis leads to the notion of a symbiotic relationship developing between the Core and the Edge – advances in one feeding another; needs in one spurring advances in the other. Neither the edge industries nor the network providers can live, and prosper, without the other. But what is missing are the information technology and the robust policies and dynamic processes that would provide a Collaborative Systematics for managing and facilitating this symbiosis. We propose calling this missing ecosystem opportunity **SPACE:** Services Provider Autonomic Collaboration Environment**.**

If Edge providers and Network providers are going to find a meaningful way to collaborate, then the OSS/BSS community can positively impact this great undertaking. Our experience in practical, timely, agile, and scalable management and transaction systems can be of great benefit to these edge communities, and therefore should become a great incentive for them to work with the owners of these systems, the network service providers. On sensor network management: "We achieve this by pursuing hybrid architecture; one, in which a central knowledgebase and reasoning engine support an overall decentralized architecture that consists of a collection of autonomous mobile agents that are capable of intelligent data gathering and performing local reasoning tasks." [Carl Kesselman] The TMF pioneered this work in the Finegrain NGOSS project.

On inventory and supply chain: "Telcos need to consider the entire *Order-to-Cash* process for such bundles and mixed offerings, and understand all the customer, OSS and BSS touch points. With this evolution in mind, the Global Business Association (GBA) has been working on an expansion of the business process map for Revenue Management, and has been exploring the synergies and extensions to eTOM." [Alex Leslie, GBA Director of Strategy , *TM Forum*]

David Milham of Milham Consulting, a TMF Distinguished Fellow, is a critical asset to the TMF's supply chain program: "recent Supply Chain Architecture work has been specifically designed to provide consistent processes, and consistent ways of tailoring the processes to specific product business models" – including application and content. "This approach supports re-use of B2B gateways that are simply configured to met specific product needs, rather than individually designed per product." This requires extensive new deployments of more complex B2B processes with many more trading partners: potentially every group at the edge. Again Milham: "Without a consistent B2B model for on-ramping new Service Providers and new Service mash-ups, Service Delivery Frameworks would be yet another lab demonstration or hobby, and not an agile business operation working reliably economically and at high volume."

The resources for these solutions can be closer that we think; under our noses even if out of current sight. This B2B gateway requirement reminds us of similar needs of financial networks and supply chain order flows; problems solved with rich B2B SOAs like AT&T subsidiary Sterling Commerce's GIS infrastructure product that even today does manage such information networks.

What does the service provider have to offer which is still difficult for the Edge to grasp? One of these is management and resiliency contained in our understanding of BOSS. [BOSS is Business and Operating Support Services; defined as the union of OSS and BSS as many discrete SOA services.] So we need to teach and demonstrate its critical nature – without which networks would grind to a halt. But this means the BOSS ecosystem must embrace and learn to navigate in a wider ocean and rougher, more complex seas. Among other things, BOSS will need to scale to handle the scope of these larger seas and the policies and processes will be more complex. Thankfully, it need not be all Greenfield development; new tools like Gigaspaces can help ISVs and SPs reengineer existing platforms to meet these expanded needs.

## Navigating the Reefs

Can we actually develop the managed symbiosis that we called (in the January 2008 article *SDF: the Service Providers Mashup*) the "*Garden Club*"? Can Network and Edge navigate together through the reefs to reach the clear waters of mutual profitability?

The transformation of telecom is a survival issue. Edge and Networks each bring part of the survival kit, but they need to pool resources and capabilities, or both may founder. How else are we prevent a new tragedy of the commons, like today's overfishing of the ocean? And avoid the punitive regulation which consequentially follows! There are still significant political and policy hurdles that need to be addressed or no amount of new collaborative technology will help.

Phil Johnston reports: "It is a real challenge to get intelligent neighborhoods and network providers to collaborate to accelerate successful growth in this market. Today's network providers are not interested in accelerating these networks, they would have to spend money and change their way of operating. Unless existing [network] service providers respond to our unique needs, new startup service providers have an opportunity to take over new neighborhoods and build a smart community taking the business away from the major network providers."

In response to our article on OTT services a telecom executive wrote back, "being able to charge a fee for those who produce services and content to have access to higher bandwidth on the Internet will insure that those companies benefiting from expanding benefit appropriately pay for the infrastructure that their services are consuming. At the same time, the existing infrastructure is not compromised and bandwidth is maintained and evolved for those not abusing the bandwidth. In effect, those benefiting from commercialization of the internet through their ever expanding bandwidth consuming services and content will pay their fair share for the infrastructure."

True, we need business models that are fair to all players, Edge and Core; and to end users who, remember, it helps to keep happy. Even Edge providers would hardly disagree with this objective – the issue is going to be over what each side believes to be "fair".

The potential of the Edge, coupled with the right network, is greater than the Edge in contention with the Network. But this must be based on some form of partnership, seen by both Edge and Network players as a win-win model. Network service providers should not expect to deploy vast IMS systems and demand that users obey rules designed only to enrich the service provider. Instead they need to present a convincing case for the value that IMS can bring to its customers, which includes the Edge providers.

Nor can Edge users and intranet portals expect use of a network designed and paid for by others except on reasonable commercial terms. We need new strategies and business models that will convince the Edge community that it is better to collaborate, but this requires that the telecom network community presents some convincing value propositions for services that will play to Edge providers' real needs.

We think the time is now. As old Bill Shakespeare pointed out …

*There is a tide in the affairs of men*
*Which, taken at the flood, leads on to fortune;*
*Omitted, all the voyage of their life*
*Is bound in shallows and in miseries.*

*On such a full sea are we now afloat,*
*And we must take the current when it serves*
*Or lose our ventures.*

- *End –*