Future Applications and the Network they will need

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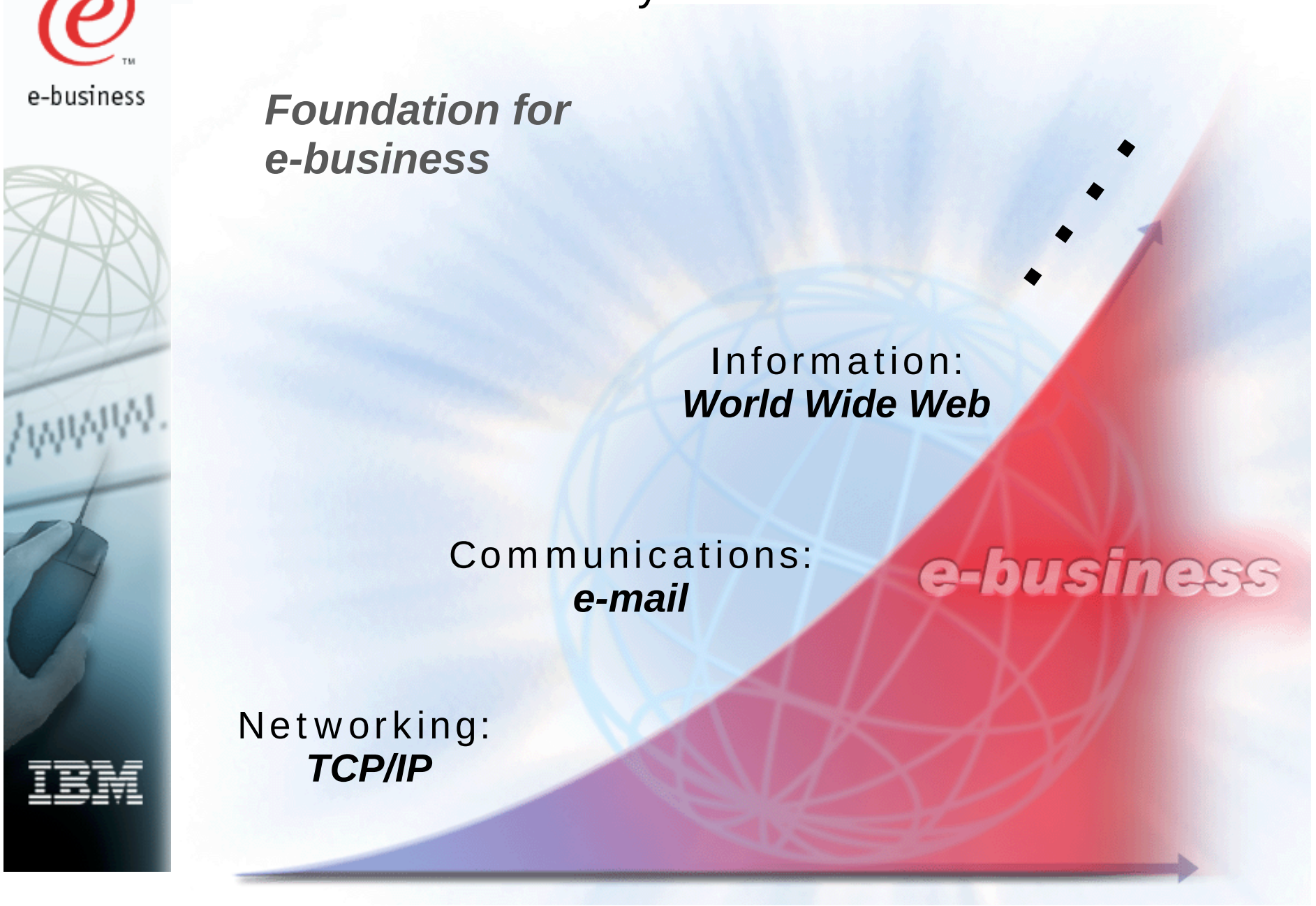
Topics

- The Internet today: as far as Web Services
- The Internet tomorrow: the Grid transforms into a computing platform
- Releasing known potential with IPv6, and identifying the opportunity costs of staying with IPv4

The Internet Today

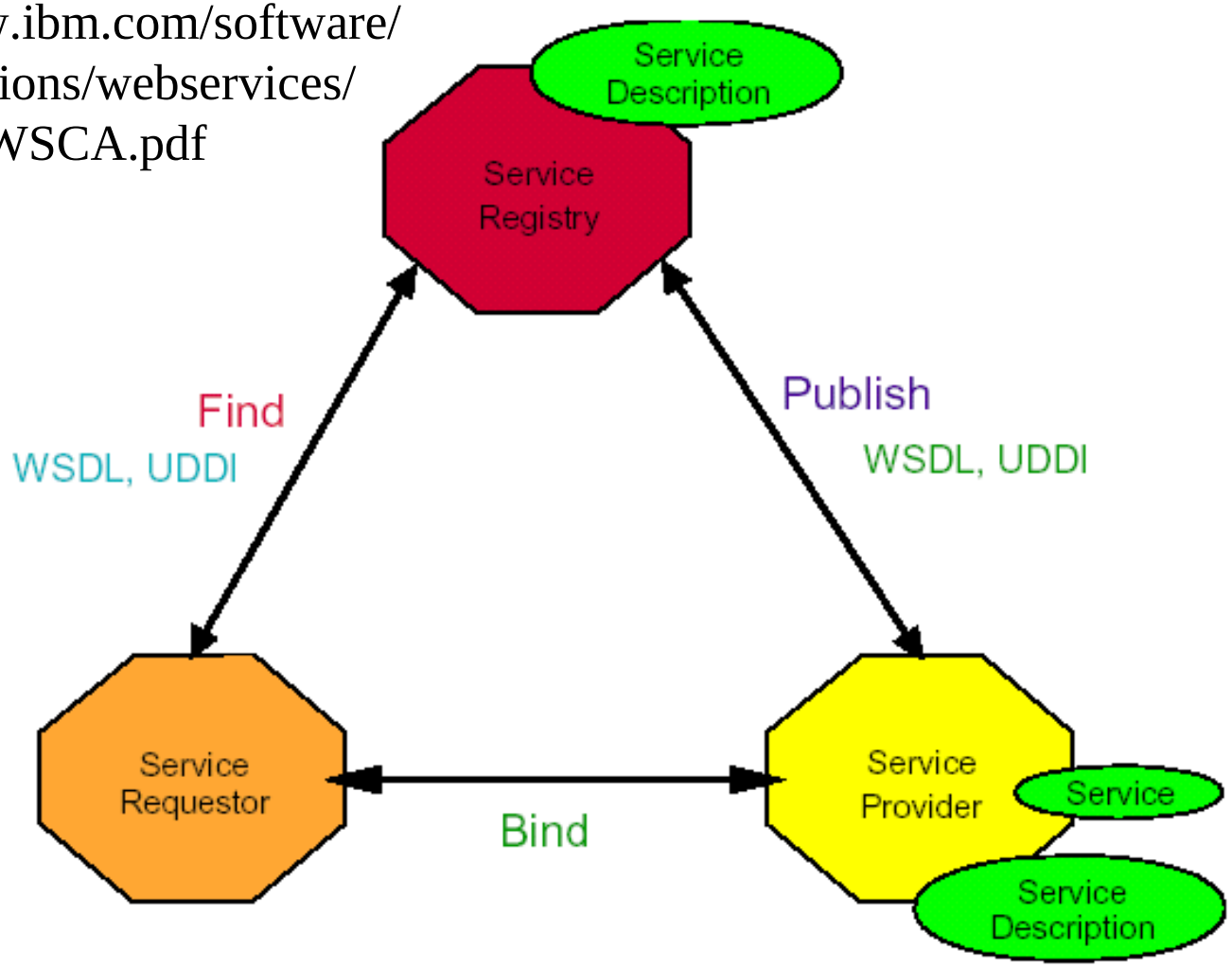


What we have today

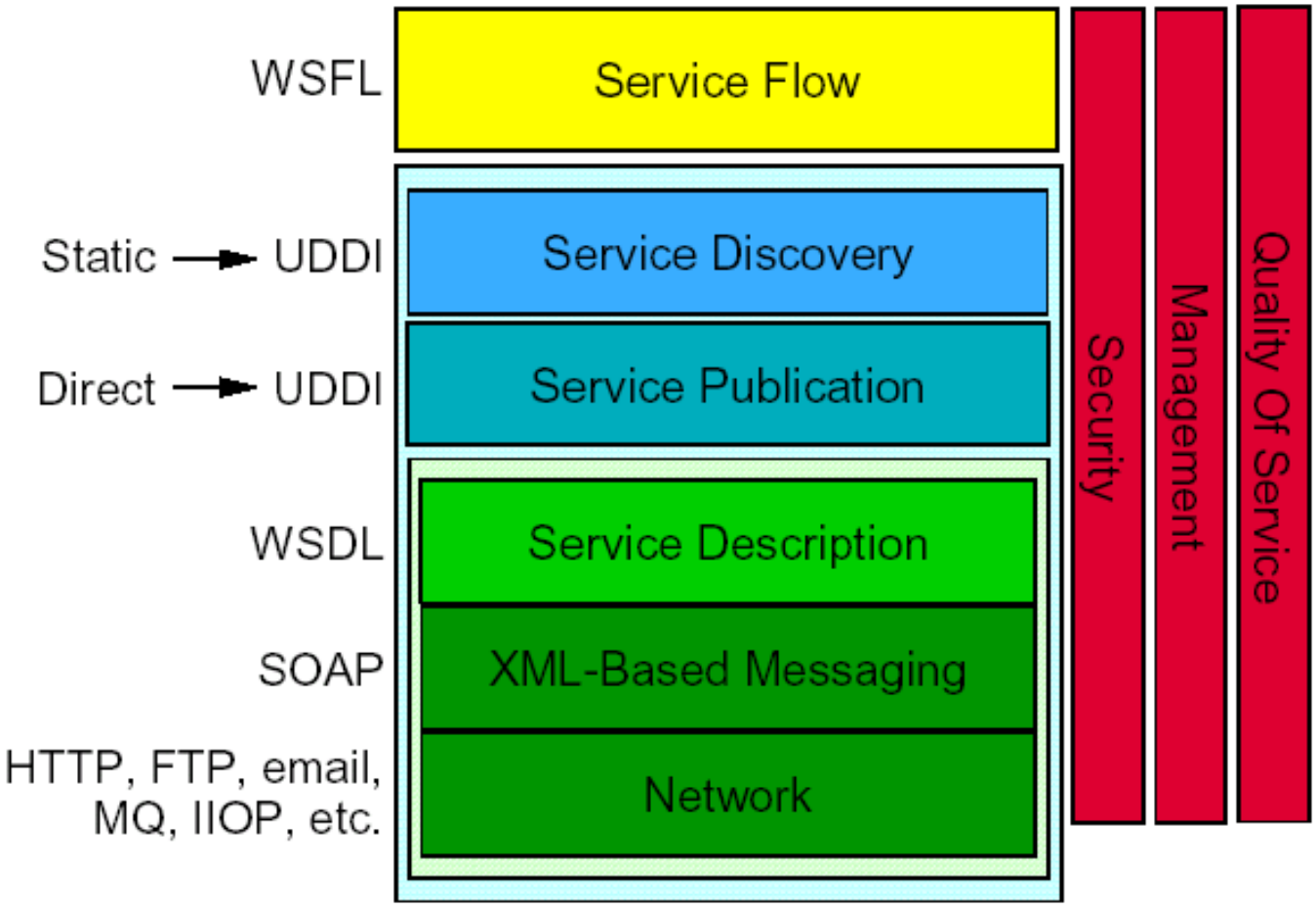
- An information web – the normal mode is for clients (users) to suck down bits from a server, like young birds in a nest suck down food from their parents.
  - Using the web to do stuff (buy, sell, play, work) is still somewhat the exception.
  - Using the web on the move is still the exception.
  - Fully trusting the web is still the exception.
- ***Web Services*** are just starting

Web Services: getting away from the simple client/server model

www.ibm.com/software/solutions/webservices/pdf/WSCA.pdf



The conceptual Web Services stack



Web Services and IPv6

- Yes, we can build Web Services over IPv4
  - by using HTTP as a Trojan Horse protocol to punch SOAP through barriers
  - by putting up with NAT glitches
  - by constraining some systems to be pure clients
- We could do it much more cleanly with IPv6
  - use any appropriate end-to-end tranpsort protocol under SOAP
  - allow any system to act as requestor or provider or both

Factors for continued change and growth

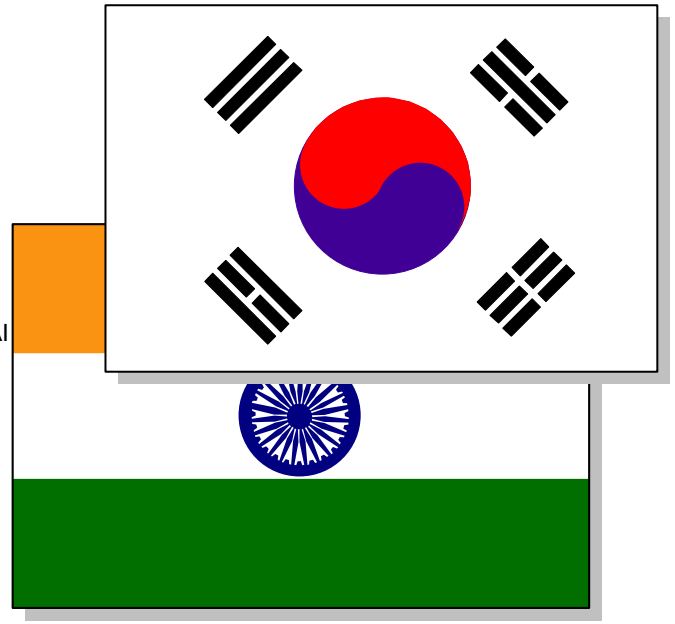
- Marketplace requirements
- Technology and the appetite for technology feed on each other
- Internet culture of open standards

Marketplace Requirements

- More efficient use of IT resources
  - Computing, storage, transactions,…
- Industrial strength infrastructure
  - 7x24, security, disaster recovery
- Integrated, but flexible
  - Distributed, centralized, outsourced..
- Impatient consumers
  - Fast, always on, everywhere, natural, intelligent, easy, and trusted

Growth refuses to slow down

- Network costs now beat Moore's law
- New countries are showing an interest
  - Let's bet on the 10 billion node Internet



Culture of Standards

The Next Generation of the Internet

Advancing e-business into the Future

Computing:
The Grid

Information:
World Wide Web

Communications:
e-mail

Networking:
TCP/IP

e-business

What is behind Grid computing?

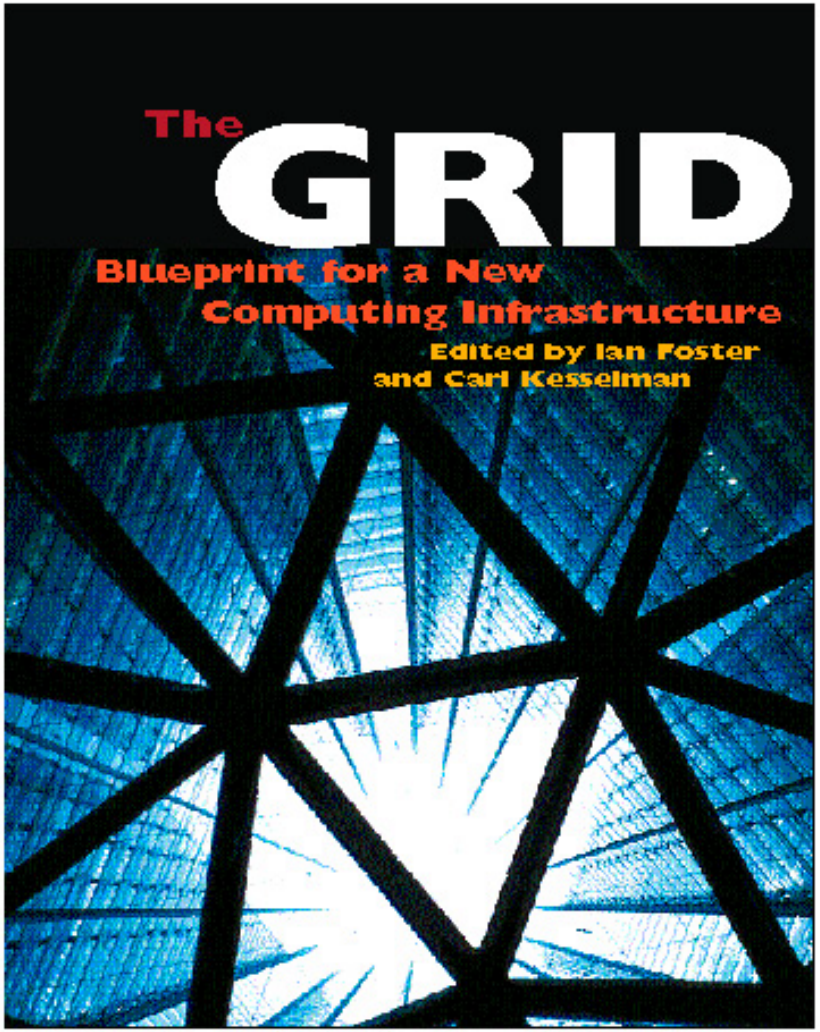
- There have been dramatic reductions in the cost of servers, storage, and wide-area bandwidth.
- The systems world shows significant convergence on TCP/IP & Unix/Linux.
- Service levels, resource management, and security are ever more critical.
- Expertise is as expensive as ever.

Abstract concept of a Grid

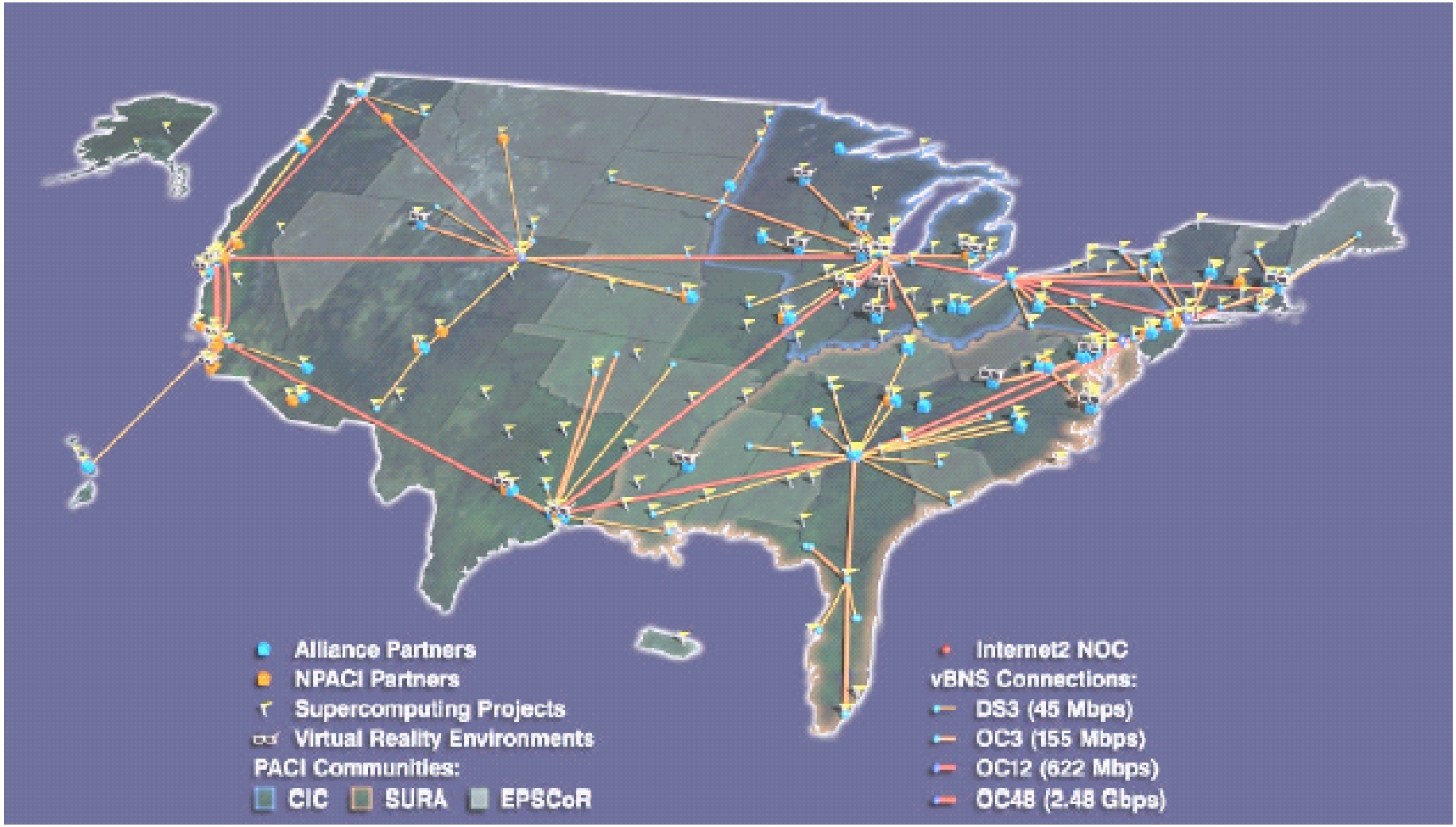
- Like public utilities, e.g. electricity grid
  - Shared
  - Reliable
  - Running it is someone else's problem
- A computing Grid is a mechanism to "coordinate resource sharing and problem solving in or between physically dispersed virtual organizations."

The book…

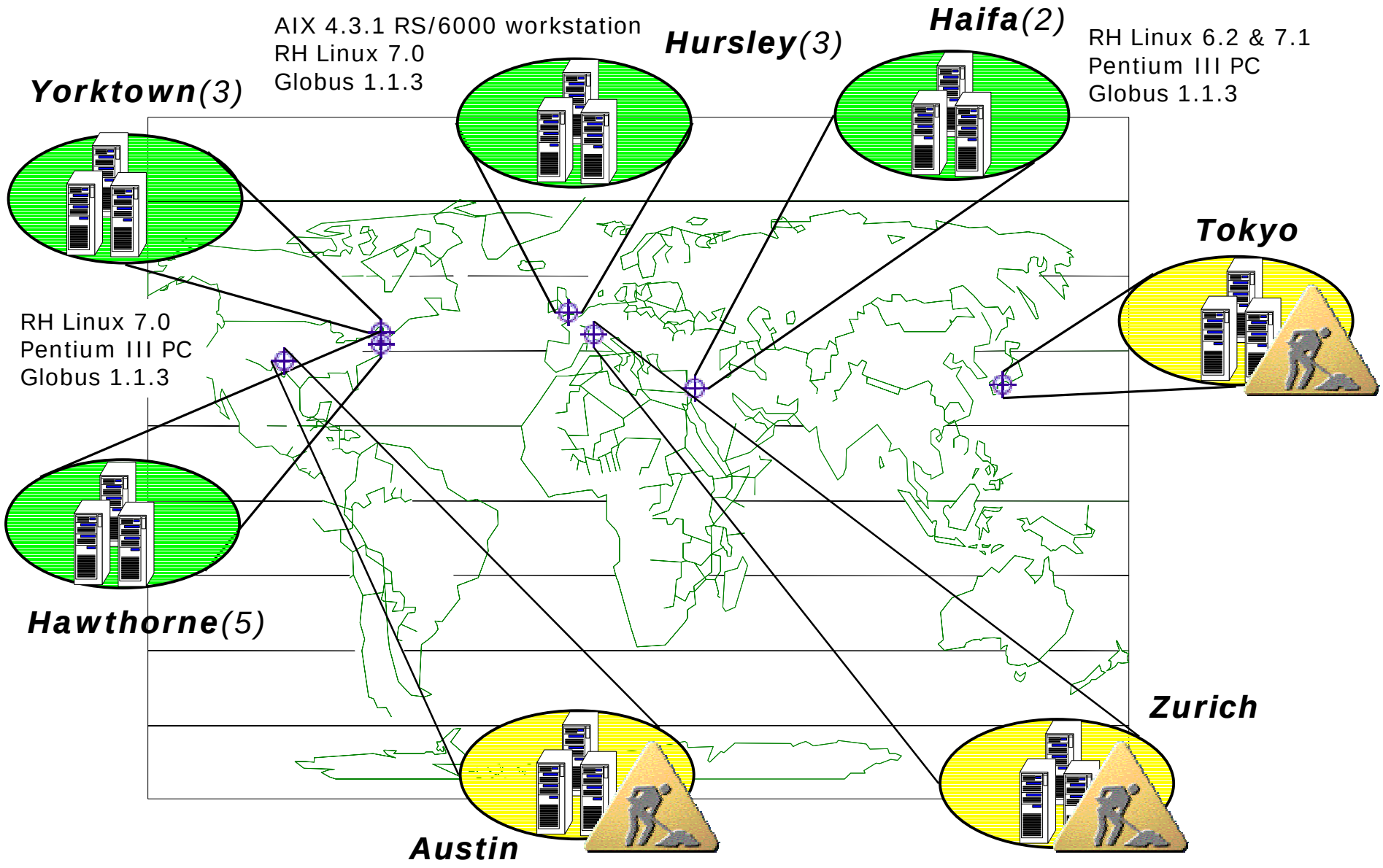
Some material is quoted from Ian Foster and Carl Kesselman. Their book is at www.mkp.com/grids



NSF National Technology Grid



Blue Grid Test-Bed



What applications are suitable for a Computational or Data Grid?

- Many traditional High Performance Computing applications, e.g.
  - Big Physics
  - Seismology
  - Protein analysis
  - Bioinformatics, medical imaging
- Large-scale engineering design
  - Automobile & aerospace design
- Financial systems
  - Market modelling

Why it isn't trivial to do

- "Lack of central control, omniscience, trust"
- "Challenge: *enable*, *maintain*, & *control* resource sharing to achieve a common goal"
- Heterogeneity, WANness (latency and disconnects), scale, autonomy, dynamic nature, unpredictability, privacy, security
- Need to match or exceed the resilience and self-healing of the Internet itself
- Need end-to-end transparent connectivity at potentially massive scale: <u>not with IPv4 addresses.</u>

GLOBUS

- GLOBUS is the principal open source Grid toolkit developed initially by the “big science” computing community in the US (Argonne National Lab, USC, etc.)
- Freely available for various platforms under its own open source licence at http://www.globus.org
- Open standards work starting in the Global Grid Forum, http://www.gridforum.org

GLOBUS architectural model

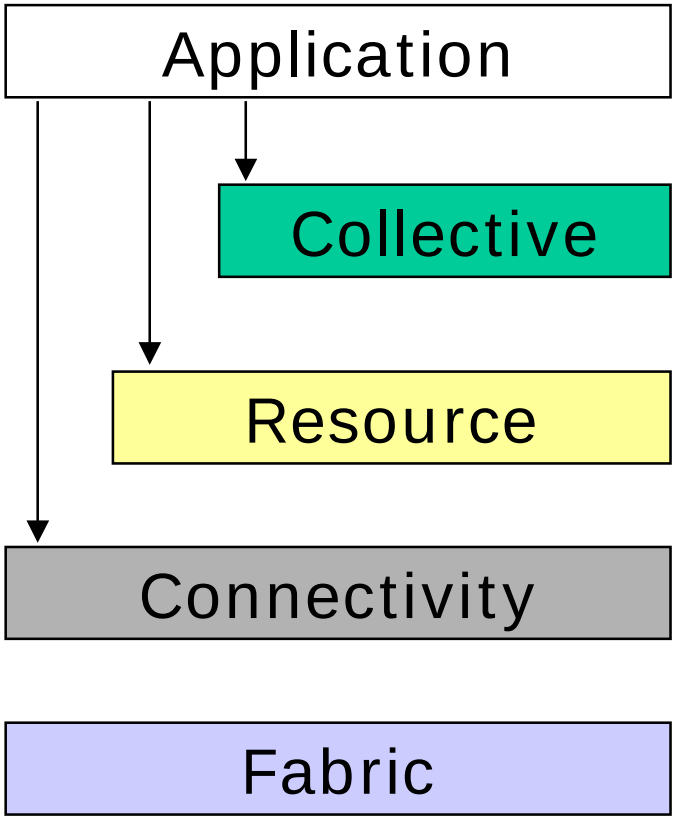
(Foster & Kesselman)

"Coordinating multiple resources": ubiquitous infrastructure services, app-specific distributed services

"Sharing single resources": negotiating access, controlling use

"Talking to things": communication (Internet protocols) & security

"Controlling things locally": Access to, & control of, resources



Industry trends

- Grid computing today is not the same as Web Services, but it was driven in the scientific world by the same forces that drove Web Services for dynamic e-business:
  - *evolving costs*
  - *systems convergence*
  - *resource sharing on the network*
  - *service levels*
  - *security*.

Thus: the Internet as a Computing Platform

- Building an open infrastructure
  - Web Services and Grid Computing Protocols
- Managing the infrastructure
  - Autonomic Computing
- Accessing the infrastructure
  - "Utility" Computing

Why the Internet as a Computing Platform needs IPv6

- 10 billion nodes squeezed into 4 billion IPv4 addresses –why would we do that to ourselves?
- Immediate benefit for applications that are being actively hurt by NAT today
  - release the known potential
- Strategic benefit for the next 50 years at least
  - the opportunity cost of staying with IPv4

Releasing the known potential (1)

- VoIP
  - stop wasting resource on NAT beating
- 3G
  - start with a clean addressing & routing scenario for “Internet on the run”
- Web Services & e-business in general
  - stop using HTTP as a Trojan Horse
  - enable all nodes to be providers
  - **e-business will pervade every SME**

Releasing the known potential (2)

- Distributed and virtual enterprises
  - enable true end-to-end network security
  - simplify mergers & acquisitions (merging two Net 10s is a major cost)
  - enable massive scale Grids and generalised e-utilities: **everybody wins economies of scale as the IT market grows**

Opportunity cost of staying with IPv4 (1)

- The networked home & school
  - Entertainment becomes on-demand and largely interactive
  - Education… ditto
  - **Expand the IT market into every corner of life**
    - Needs broadband, but needs addresses too (interactive groups for learning or playing require peer-to-peer transparency)

Opportunity cost of staying with IPv4 (2)

- Emerging markets
  - Only a tiny percentage of the world population have Internet access today
  - Over the next 50 years, let's aim to get to all of them: make our market **20 to 50 times bigger.** Good for business, but good for society too.
    - Needless to say, we can't do this without enough address space

An application forerunner: 6net

- IBM is coordinating the “middleware and user application trials” work package of the EU 6NET project
  - videoconferencing and media streaming
  - on-line games
  - e-business and Grid solutions
  - edge services for IPv6
- http://www.6net.org

Summary

- We’ve managed to get as far as Web Services, just, with IPv4 and some kludges (NAT-beating, HTTP as a Trojan Horse).
- As growth continues, the Grid will transform the Internet into a computing platform, but it too will get stuck on the rough edges of NAT boxes.
- IPv6 will release known IT market potential in the medium term
- IPv6 will avoid the opportunity cost of staying with IPv4 in the long term (multiply the potential market by 20 to 50?).