

Network Evolution, Cloud & Future Services

Opportunities & Challenges for Next-Decade
Services

Dr. Hossein Eslambolchi

CQR MAY 2012

Outline

Trends: Data, Services & Networks

Cloud

What is Next?

Law of Telecom Complexity

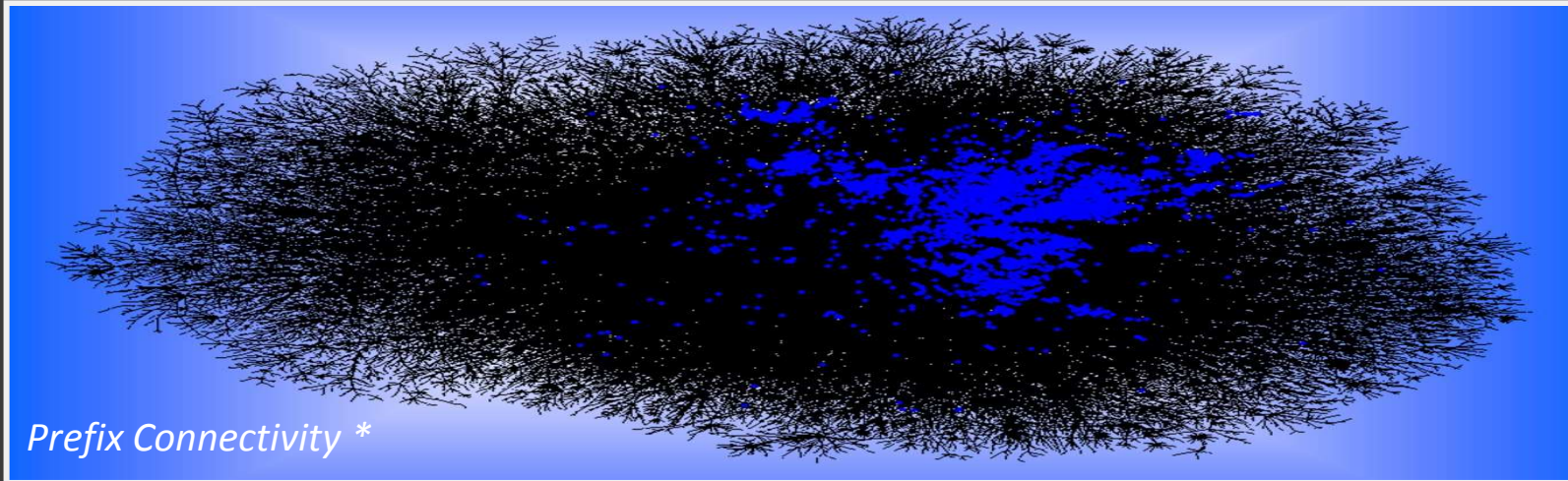
Telecom complexity, C, is calculated roughly as:

$$C \propto (\text{Number of protocol domains}) \times (\text{Number of networks per domain}) \times (\text{Average number of inter-network interfaces per network})$$

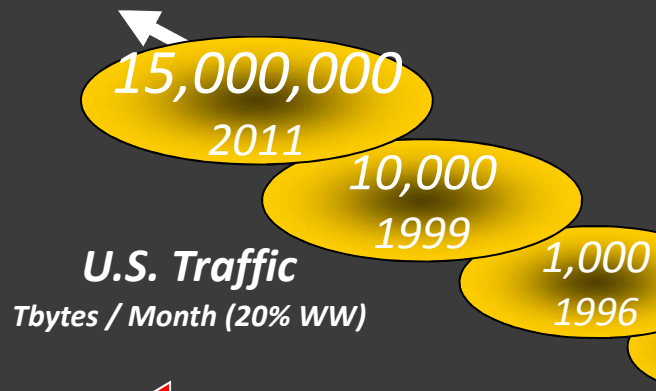
- Over time, T, the number of protocol domains increases proportional to T
 - The number of networks per domain increases proportional to T
- The number of inter-network interfaces per network is proportional to the number of networks per domain

$$\text{Hence, } C \propto T^3$$

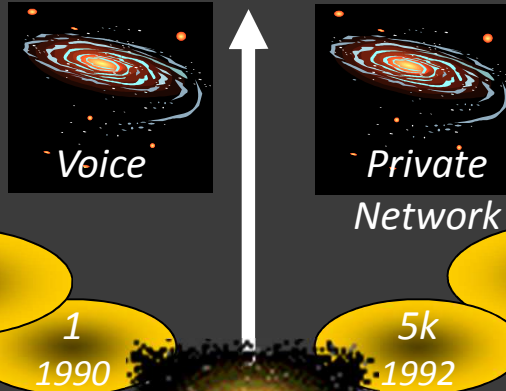
Internet Big Bang



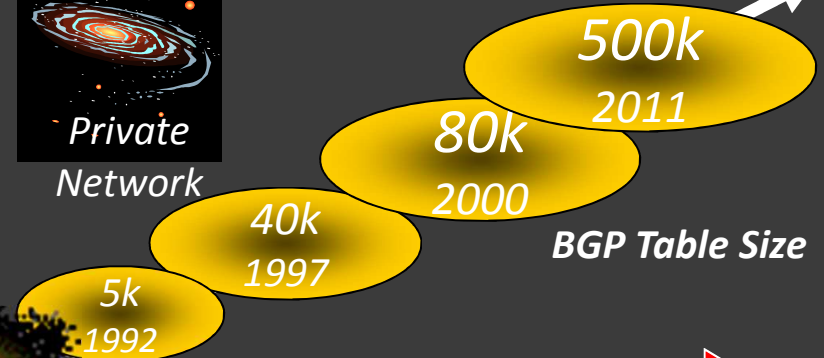
Volume Expansion



Galaxy Integration



End Point Expansion



APPLICATION EXPANSION
Wireless, SoIP, Data, Video, Gaming, Sensory, LBS

Arpanet
1969

MATTER DISTRIBUTION
P2P (Video), Grid Computing

IP Networks Must Be Ready For Sextuple Play

Already in the Zettabyte Era

Source: Cisco Global Cloud Index



Global Data Center IP Traffic Growth

Applications Moving to the Cloud

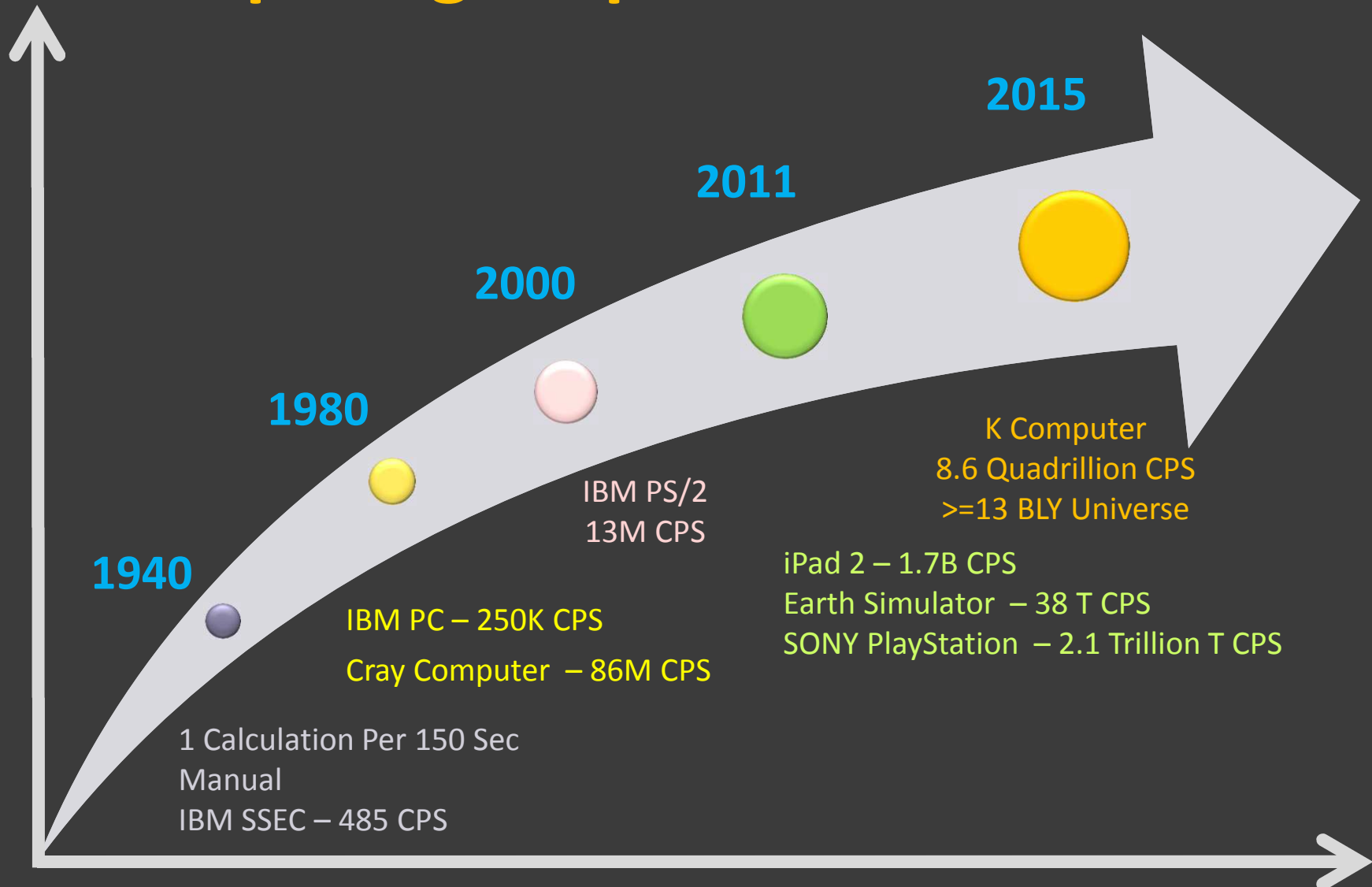
By 2014, >50% of All Workloads Will Be Processed in the Cloud



Source: Independent Analyst Shipment Data, Cisco Analysis

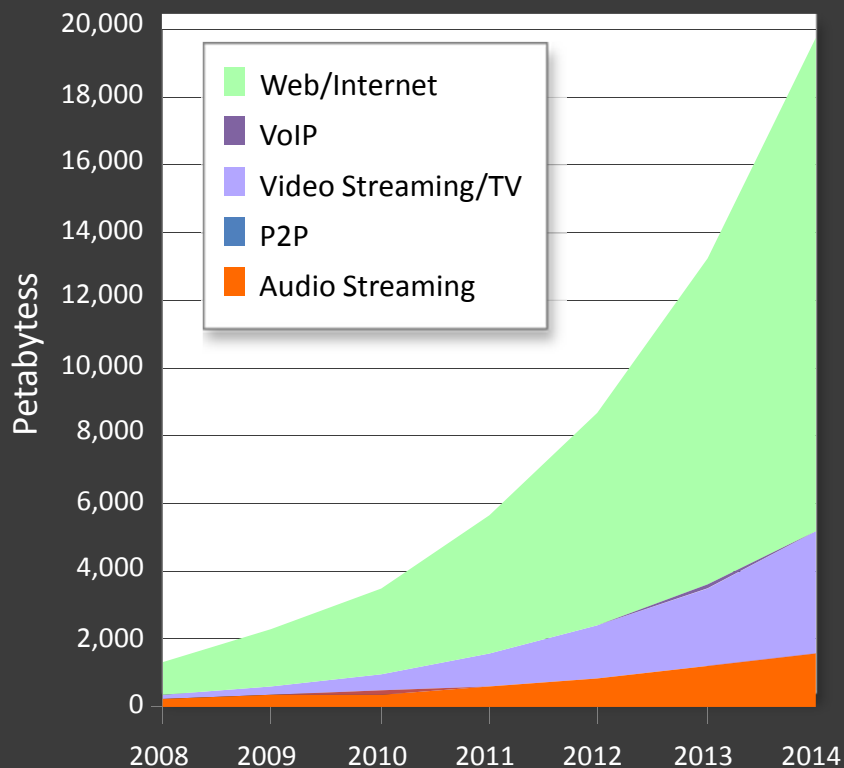
Transformation from Traditional IT to the Cloud

Rules of Machines & Cloud: Computing Surpasses Moore's Law

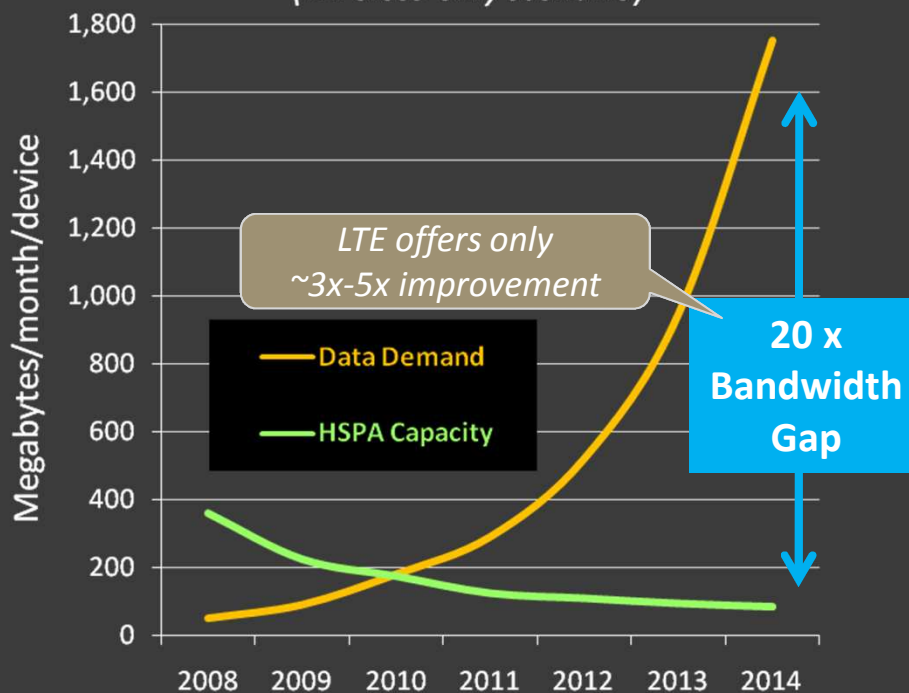


Pervasive Content = Bandwidth Crunch

Global Mobile Network Data Traffic



HSPA network capacity and data demand forecast per device for an incumbent 3G operator (wireless-only scenario)



Mobile Data Demand is Exploding Due to Pervasive Content, Leading to a Looming Bandwidth Gap

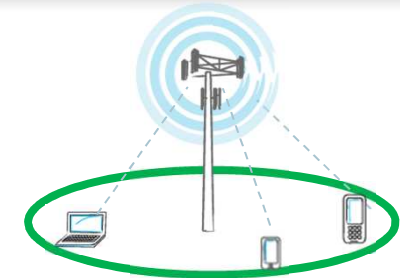
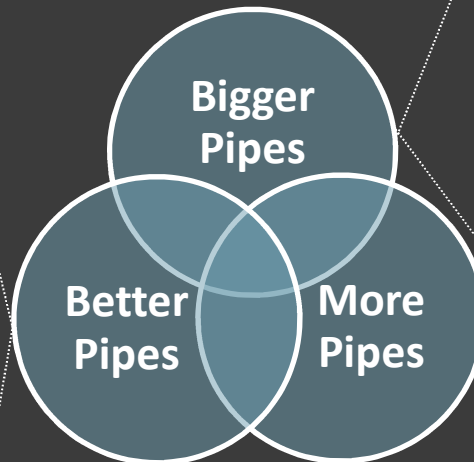
Solving the Bandwidth Crunch

Invent spectrum-multiplying solutions that enable optimal data usage and a richer multimedia experience

Compression (3-5X), caching, local content routing, streaming media (1/2 Cost and Opex), mobility

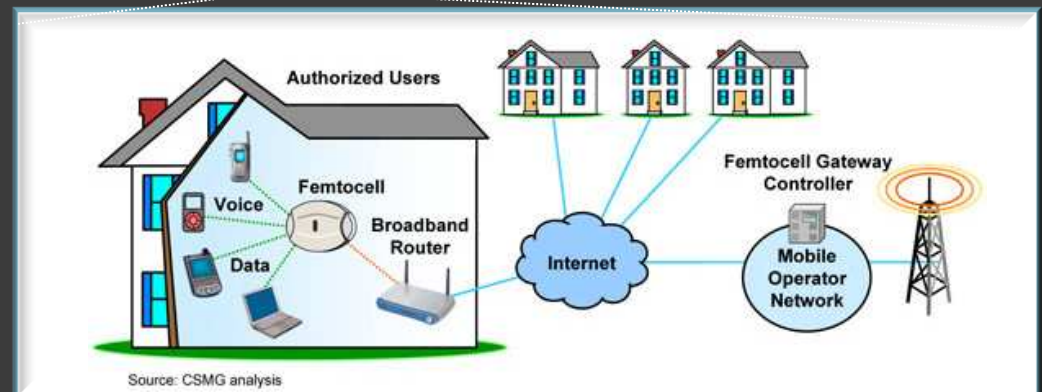


Inventions for efficient bandwidth utilization across Tier 1 networks



Push Shannon's Limit - More Bps/Hz (5 - 10X)

Maximize throughput at cell edge, uniform coverage across cell



Outline

Trends: Data, Services & Networks

Cloud

What Is Next?

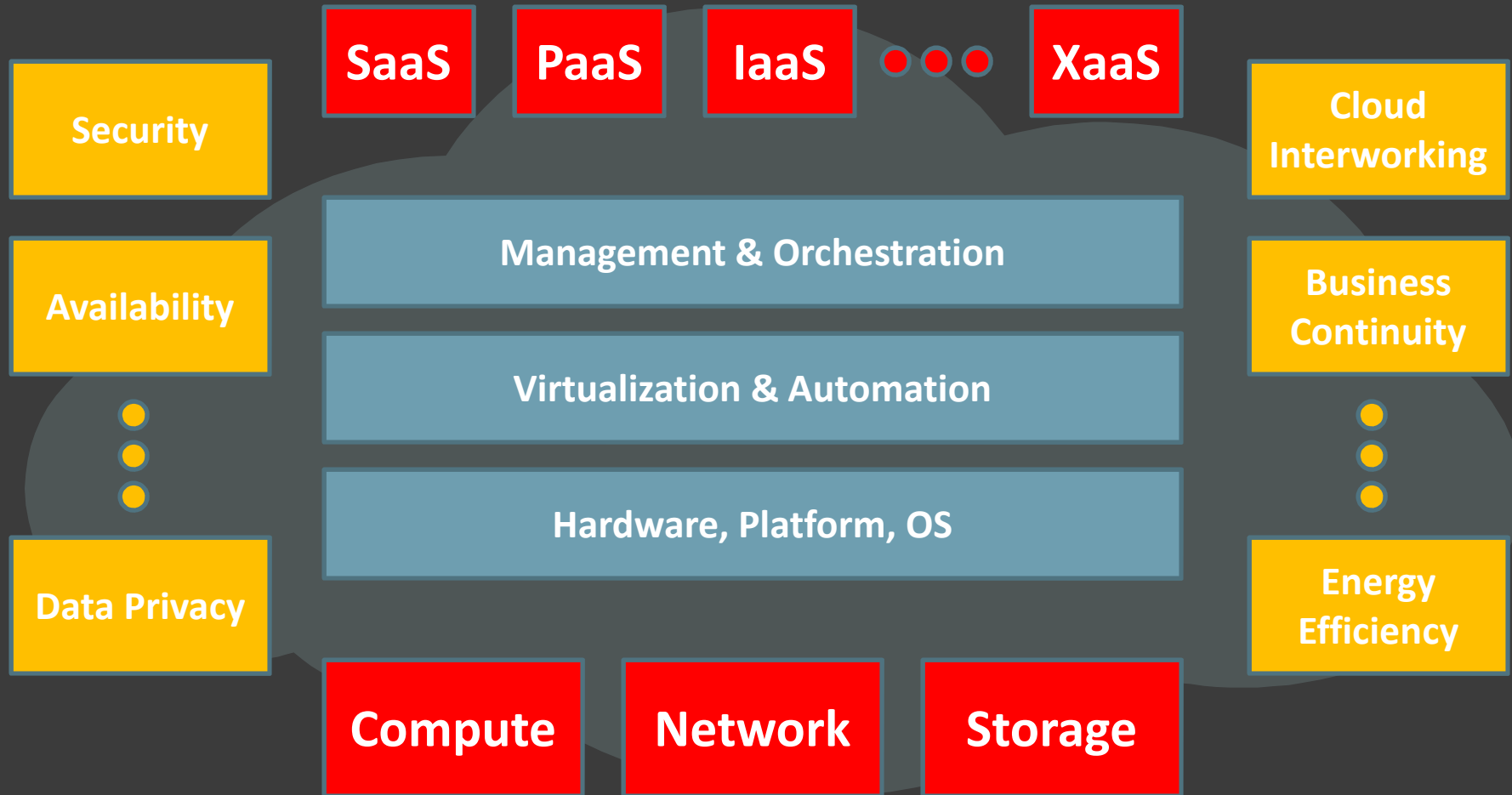
Cloud: Global Impact

Virtualisation: Servers, Storage & Computational Systems



Social, Political & Financial Considerations

Cloud Ecosystem



From Physical Silos To Network-Based IT-As-A-Service & Anything As-A-Service (XaaS)

Industry Services Over IP Vision

Layered Architecture

Integrated Feature Execution Environment – Cloud Computing Services

Collaboration



E-Commerce



Conferencing



Messaging



Video



CVoIP/BVoIP



IP Centrex



Services over IP Infrastructure Provides Advanced Services in a Uniform Environment

Common Services over IP Network Infrastructure

E911

CALEA

Peering

Global IP/MPLS

Network Functions

Border Elements & Gateways

All Access Technologies



Any End Device



Transaction-based DPM Methodology

- ↳ **Understand** how the services are provided via their transactions
- ↳ **Define** how transactions are defective for the services provided
 - **Failures** in **Accessibility**, **Continuity** & **Fulfillment** under service's
Operational Profile
 - Failure Modes and Effects Analysis (FMEA)
- ↳ **Measure** the services provided for defects on IP Edge Router
- ↳ **Analyze** what happens to the defined transactions (opportunities)
 - ↳ **Control** service to maintain a high level of quality

IP DPM Measurements

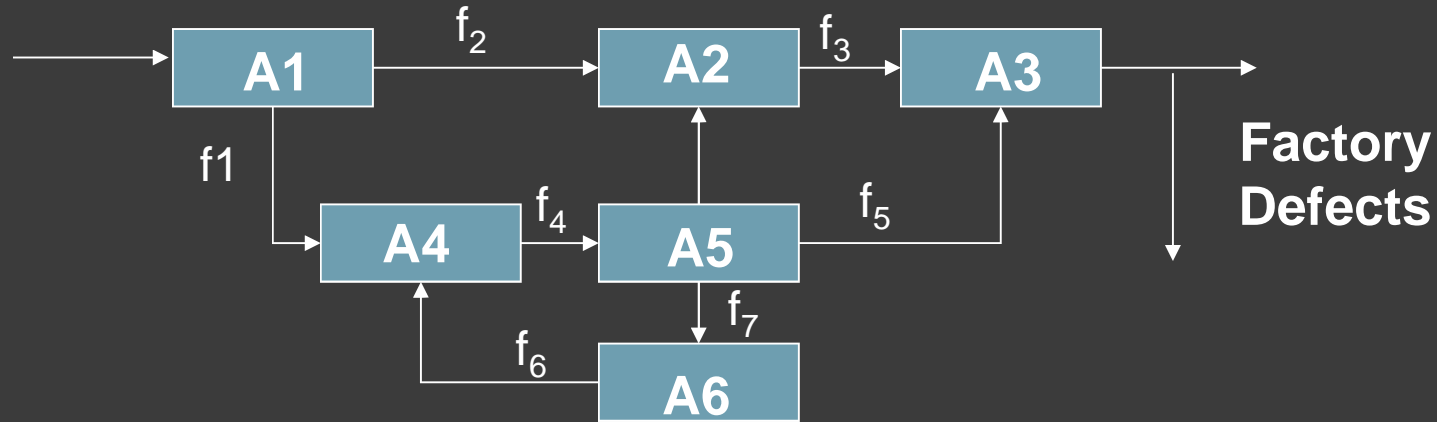
View Services as a collection of *transactions* that are invoked under a specified *Operational Profile* with a Focus on *Probability(Successful Transaction)*

- **Port Accessibility** - probability of successfully initiating a transaction. This is the *availability* of any communication path into the service.
- **Continuity** - probability of successfully completing an initiated transaction.
- **Fulfillment** - probability of completing transactions within acceptable performance/service bounds.
- **Flow-Through**: probability of automatically flowing through the factory defects

Proposal: Develop a mathematical methodology to track and link IP Edge Network defect metrics to the system and process metrics (including availability and latency) within Management Control Plane.

Factory DPMs Example

Approximate Relation of Factory Metrics System Metrics



$$\text{Factory DPM} \sim \sum_{path_j} \left(\sum_{App_i} DPM_{ij} f_{ij} \right) p_j$$

Where $path_j$ represent the j paths through the factory
 f_{ij} are the fraction of transactions that flow from App_i to App_j
 DPM_{ij} are the DPMs generated at App_i from transactions on $path_j$
 p_j is the probability of following $path_j$

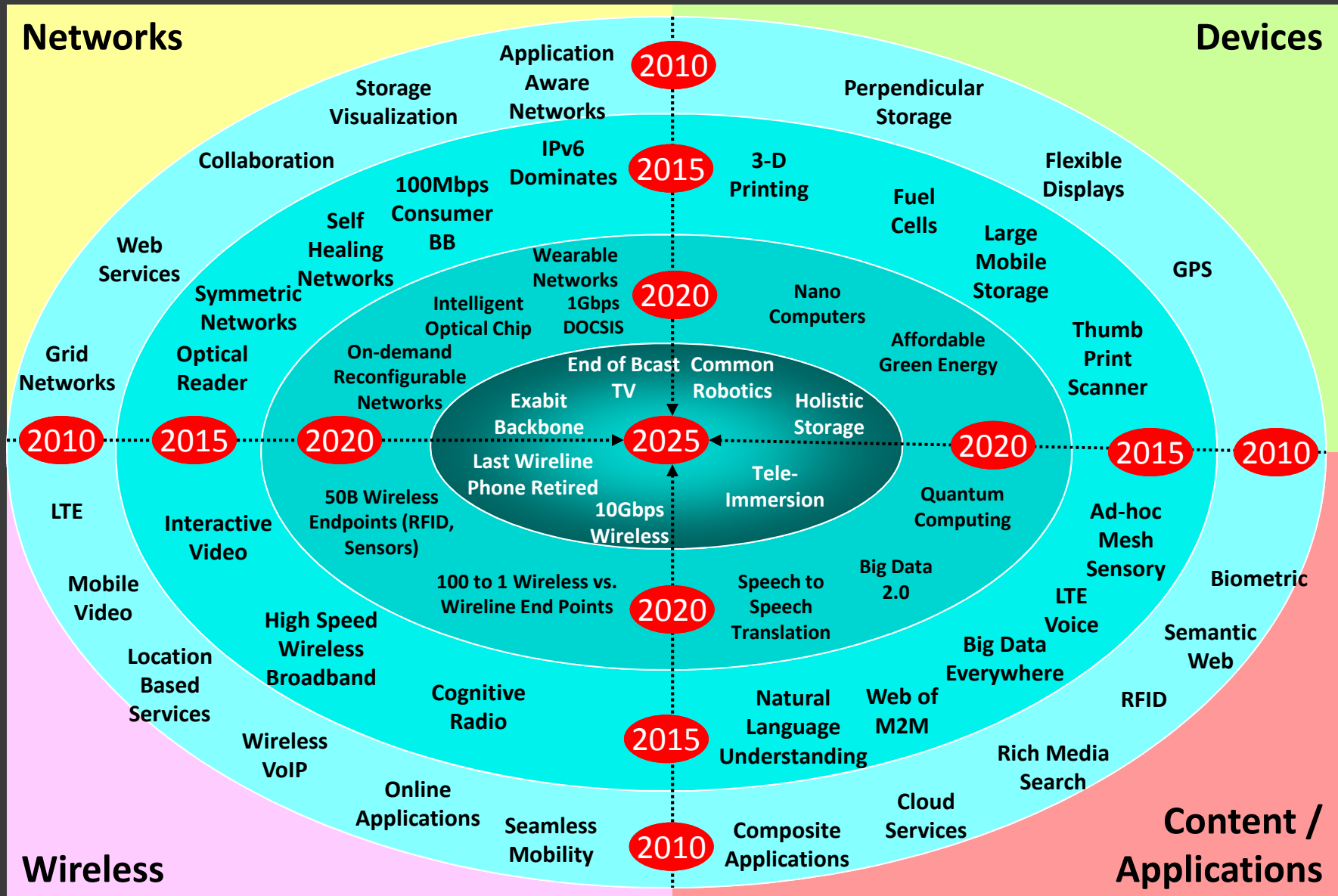
Outline

Trends: Data, Services & Networks

Cloud

What Is Next?

What Is Next?



Network Evolution, Cloud & Future Services

Opportunities & Challenges for Next-Decade
Services

Dr. Hossein Eslambolchi

CQR MAY 2012