The Second International Conference
on Advances in Satellite and Space Communications

SPACOMM 2010

June 13-19, 2010 - Athens/Glyfada, Greece

Panel SPACOMM 2010:

Tendencies and Challenges in Space Communications

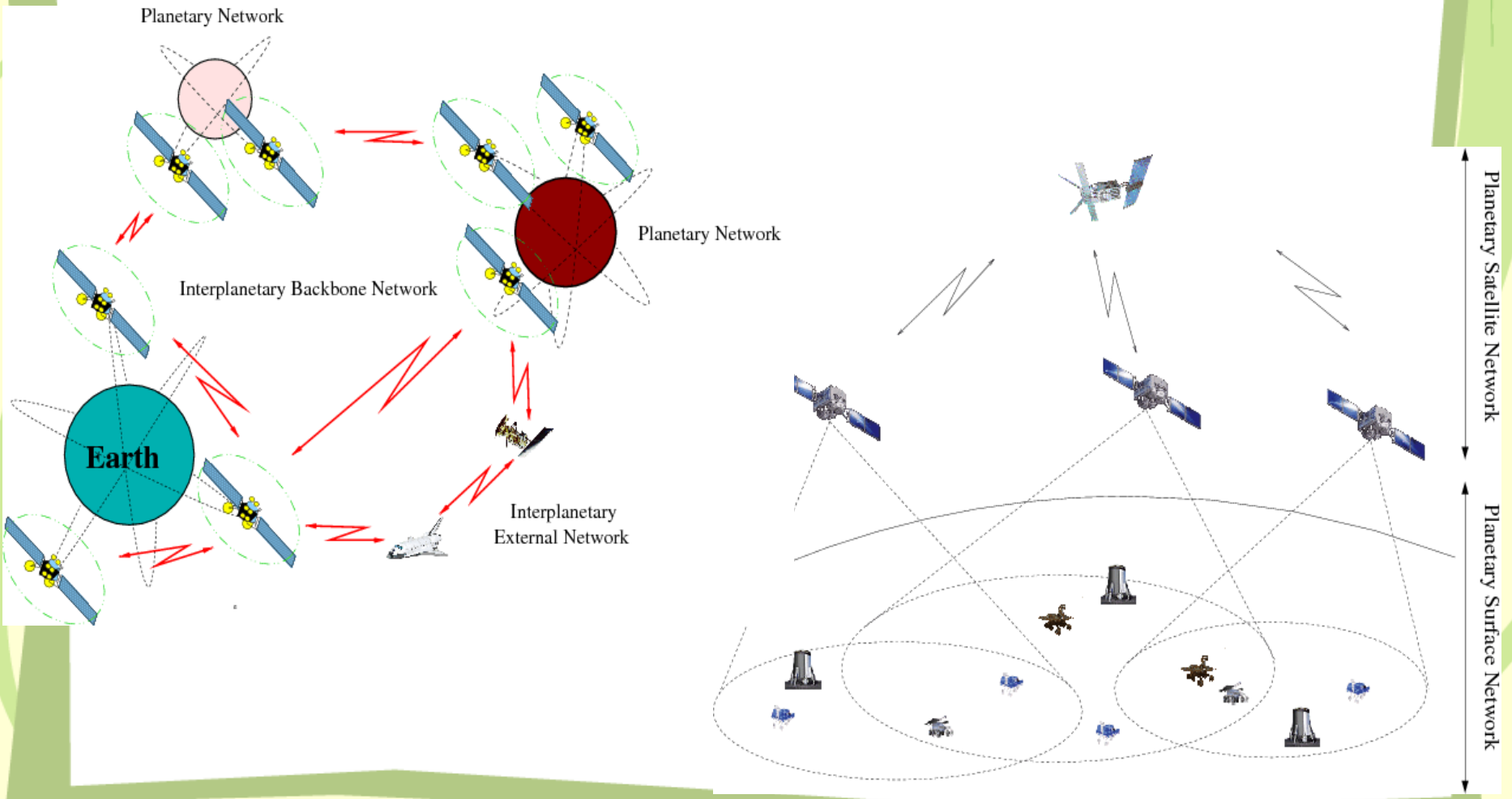
Introduction

Panelists:

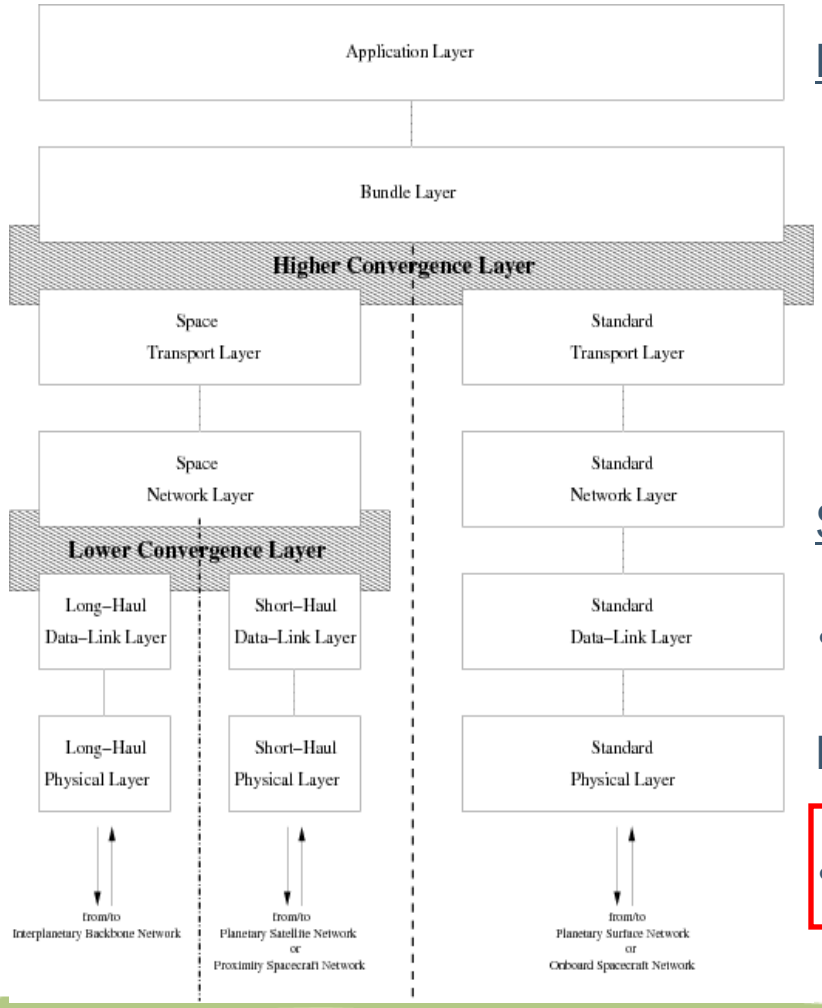
- Marc Berrill, ESA-Estec, The Netherlands
- Sergio Montenegro, German Aerospace Center (DLR), Germany
- Petre Dini, Concordia University, Canada / IARIA, USA
- Mohaned Juwad, Avanti Communications, UK

Moderator:

- Igor Bisio, University of Genoa, Italy


Planetary Network
Planetary Network
Interplanetary Backbone Network
Earth
Interplanetary
External Network
Planetary Satellite Network
Planetary Surface Network

A set of boxes for Solutions to be filled



Problems:

- long and variable;
- asymmetric capacities;
- variable error probability;
- intermittent connectivity;
- power, mass and size of hardware.

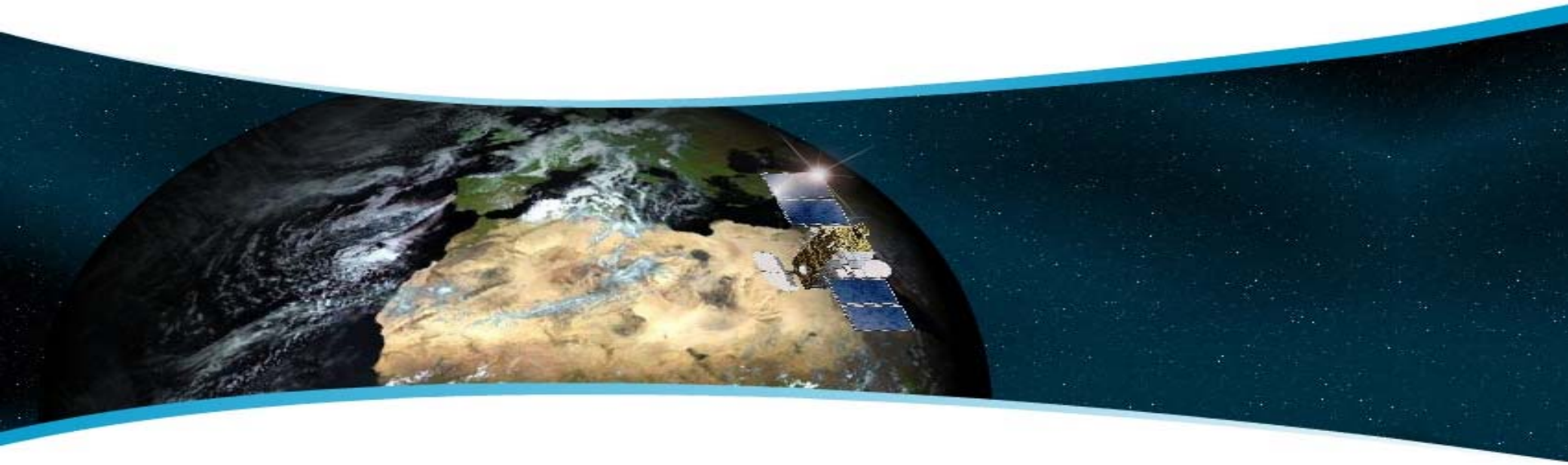
Solutions:

- some ideas from the talk of this morning;

But, in particular:

- the viewpoints of our panelists!

Tendencies &Challenges in Space Communications



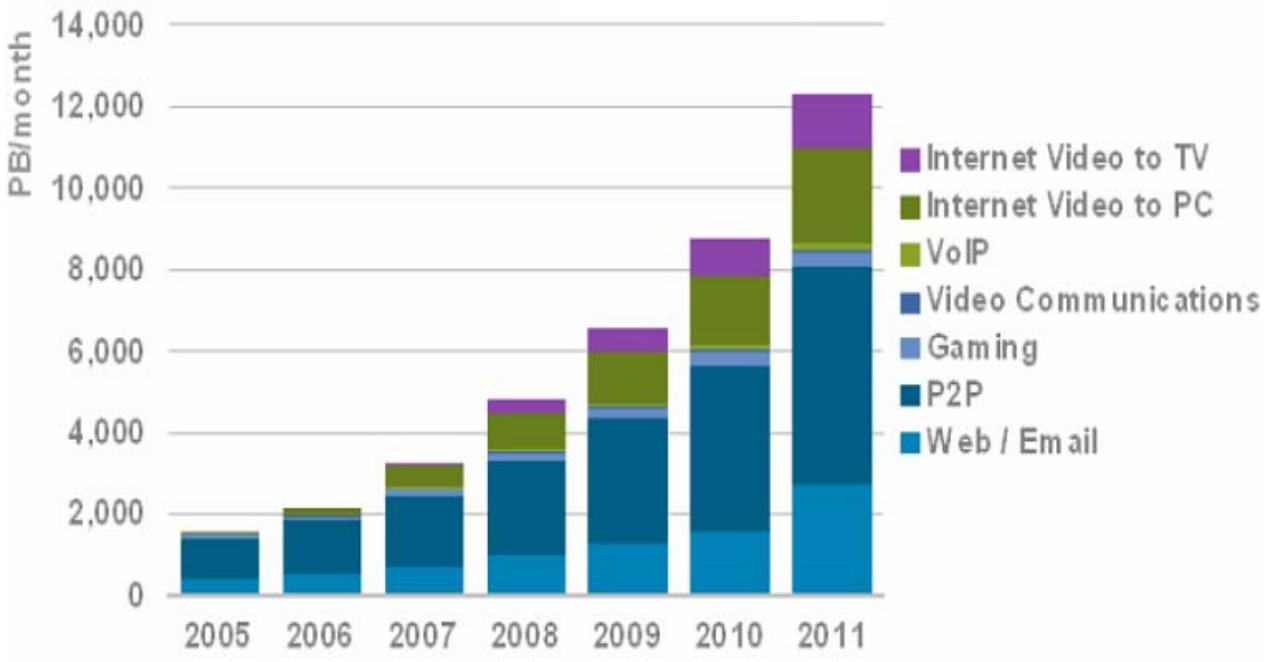
Avanti Communications Group plc

Mohaned.juwad@avantiplc.com

Avanti Communications Group

- Avanti provides broadband via satellite
- First broadband satellite (HYLAS 1) Launch 2010
- We are the European #1 specialist in Satellite Broadband
- 16% of UK homes can’t receive 2Mbps broadband
- Satellite addressable market of over 1.9 million homes (Ofcom)

Global Internet Consumer Traffic



- The annual increase of video to TV traffic from 2008 to 2011 is predicted at 61%, while video to PC will grow at a 43% annual rate
- CISCO predicts that by 2011 only 57% of all the IP traffic will be internet traffic and 43% will be video

Available Scenarios

Scenario 1 is the worst case scenario and assumes:

- All TV content is delivered on demand and considered as consumer internet traffic, which means an extra of 4.48h per day by 2021 added on top of the 1.12h that the user spends online

- There are no limitations on data consumption (GB/month) or P2P traffic

Scenario 2 is a more realistic scenario and assumes:

- Not all TV traffic is delivered on demand. A large proportion of it is multicasted or broadcasted to the users at once. Only 52% of the time spent online (2.63h by 2021) will be dedicated to watching video content

- P2P traffic will be partially filtered and video on demand will be cached locally to contribute to the reduction of P2P traffic

Motorised Antenna

- Next generation Ka-band satellite VSAT modems are becoming cheaper, to as little as €300
- In comparison the installation and alignment process is still costing an operator €250-€500 per VSAT
- Cheap Do-It-Yourself Motorised units to be installed on VSAT Antennas
- Fine alignment of 0.2 degrees for Ku/Ka satellites
- Collaboration with ESA and Avanti

THANK YOU

Questions?

Challenges in Space Communication: Space Clouds

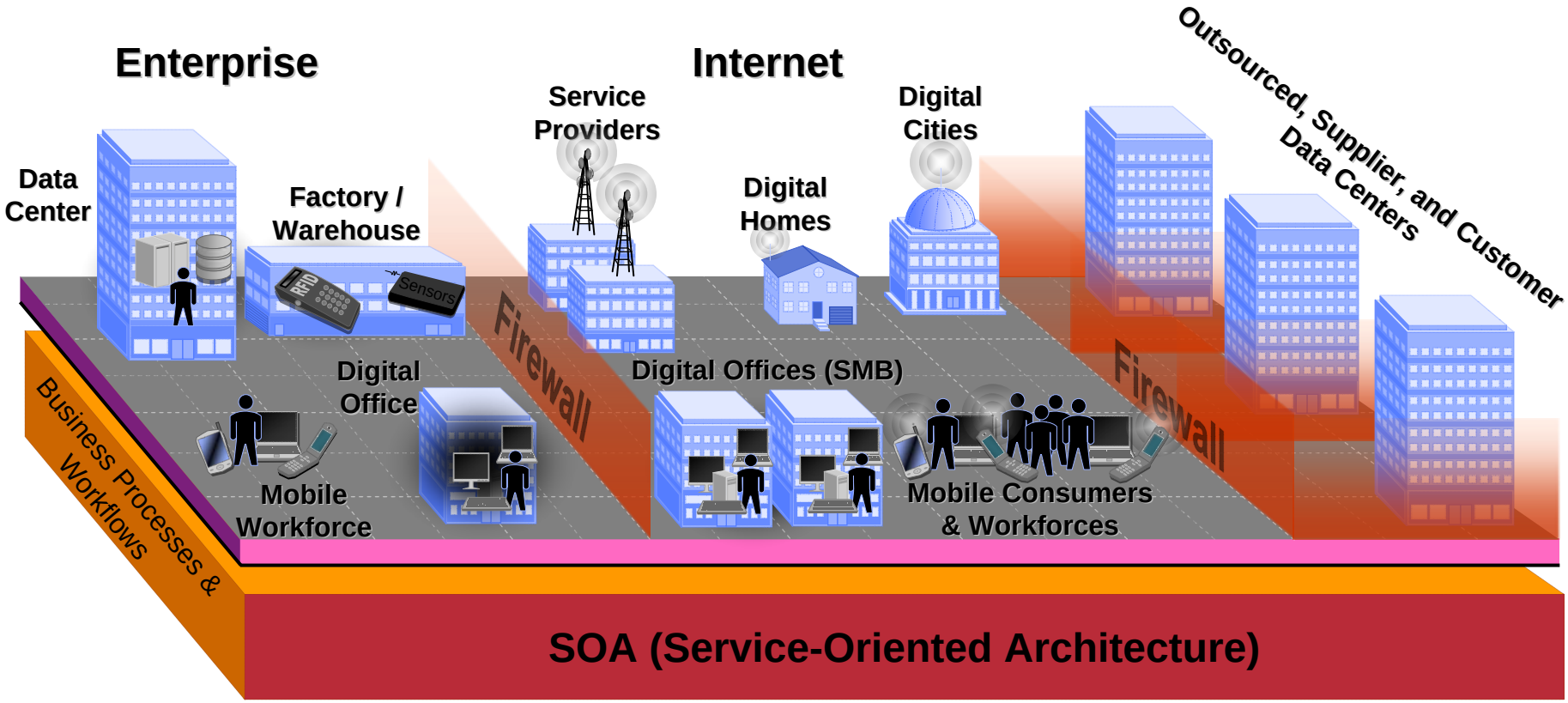
Prof. Dr. Petre Dini

IARIA / USA || Concordia University / Canada

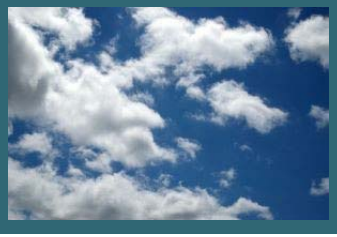
petre@iaria.org

PANEL
SPACOMM 2010
Athens, June 2010

Vision:
The Service-Oriented Enterprise



Courtesy: Robert Fogel, Intel



Achievments: Clouds

- Ubiquitous and pervasive services, as a utility
- Anything, anytime, anywhere, anybody
- Service oriented: SaaS, PaaS, IaaS, HaaS
- IT resources provisioned outside corporate data center
- Resources accessed over the Internet
- A virtual computing environment (Vmware, Xen,
- Abstraction of the hardware from the service
- Variable cost of services (QoS)
- From CapEx to OpEx
- Flexible: public and private clouds
- Build and deliver, always-on, pay-per-use IT services
- Scaling up/down: computing, storage, database, services, users

Cloud Computing can be part of:

- peer-to-peer computing and grid computing
  e.g., as an (external) node in a grid workflow

- mobile and sensor networks to process the huge amount of data

- a telecom services portfolio, driven by convergence of broadband, smart mobiles, and clouds

- service oriented start-up companies, on the fly

Clouds: computing platform for society & business services

Public (mail, schools, banking, financial, personal, real estate, health, government, insurance, hospitals, transportation, library);

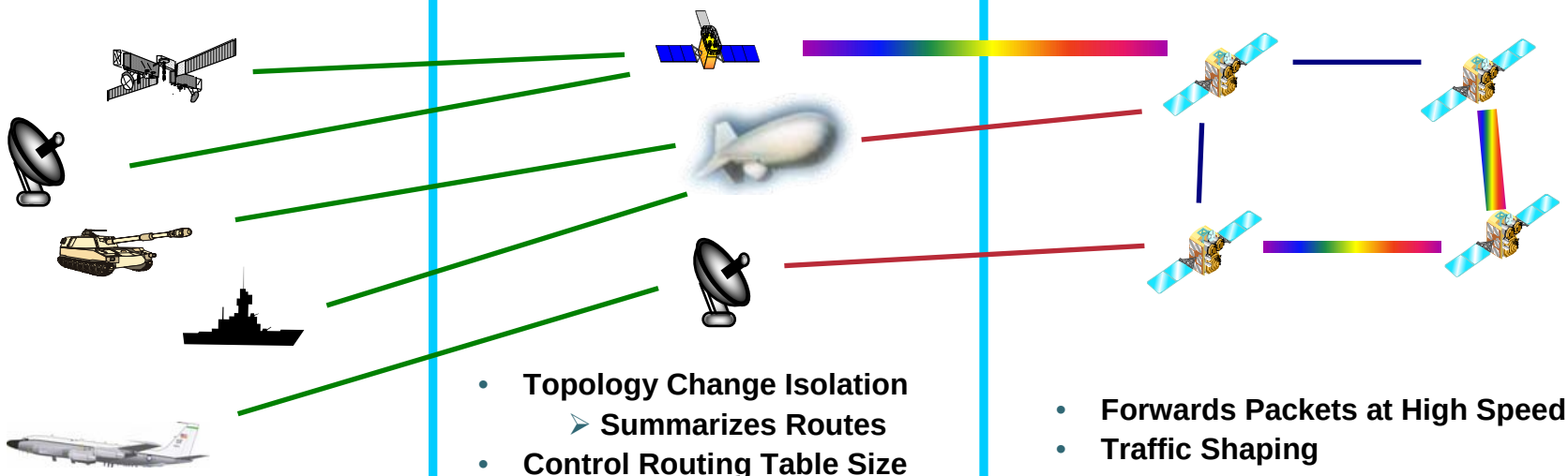
Utility (broadcasting & cable TV, printing & publishing, energy, Internet, hotels, retail, waste management, security, rental);

Entertainment (advertising, casinos & gaming, recreational, restaurant, travel);

Business (communications, specialty, technology, planning, supply chain management, marketing, design, wholesale distribution);

Business process management (business knowledge, business protocols, service level agreements, business licensing models, business financial models, and business advertising models.

Hierarchical Network Concept



- Feed Traffic Into Network
- Control Access to Network
- Perform Edge Functions
  - Authentication
  - Traffic grooming
  - Security Policies

- Topology Change Isolation
  - Summarizes Routes
- Control Routing Table Size
- Traffic Aggregation
  - Authenticates
  - Traffic types
  - Next Hop
  - Applies Policy (QoS)
  - Traffic Management
  - Packet Coloring
  - Traffic Shaping
  - SLA Enforcement

- Forwards Packets at High Speed
- Traffic Shaping
- Traffic Policing
- Determine Next Hop
- Enforce Network Policy
- Enforce Peering Arrangement

Market Analysis: The Past

- **For 50 years, global space communications has relied on large, custom, proprietary technologies driven primarily by the government**
- **Industry was high cost, risk averse and specialized**
- **Resulting in long lead times for technology development**
- **Leading space contractors found it difficult to design durable, reliable (and reusable) equipment.***

***Wall Street Journal*, Feb. 11, 2006**

Market Analysis: The Present

- **Space community demanding faster time to orbit and change in the decision-making framework for systems buyers**
- **Since 2002, the market is rebounding and redefining itself**
  - **Increase in demand for specific commercial and military satellite-based services: broadband, data and military communications**
- **Innovation from non-traditional sources with an emphasis on "Commercial of the Shelf" (COTS) and IEEE/IETF standards-based technology**
  - **International open standards shortening spacecraft time-to-build/launch cycles**
- **Innovation is resulting in flexible, converged, smaller, less costly, fully-integrated platforms and faster time to market**
  - **Estimation: COTS technologies will save 25-50% in overall mission costs (acquisition and life cycle)**
- **Collaboration and consolidation replacing narrow competition among partners**
  - **Near-term markets expanding to include many players: worldwide, independent, regional & narrowband satellite service providers; commercial avionics manufacturers; civilian organizations; defense industry**

Market Analysis: The Future

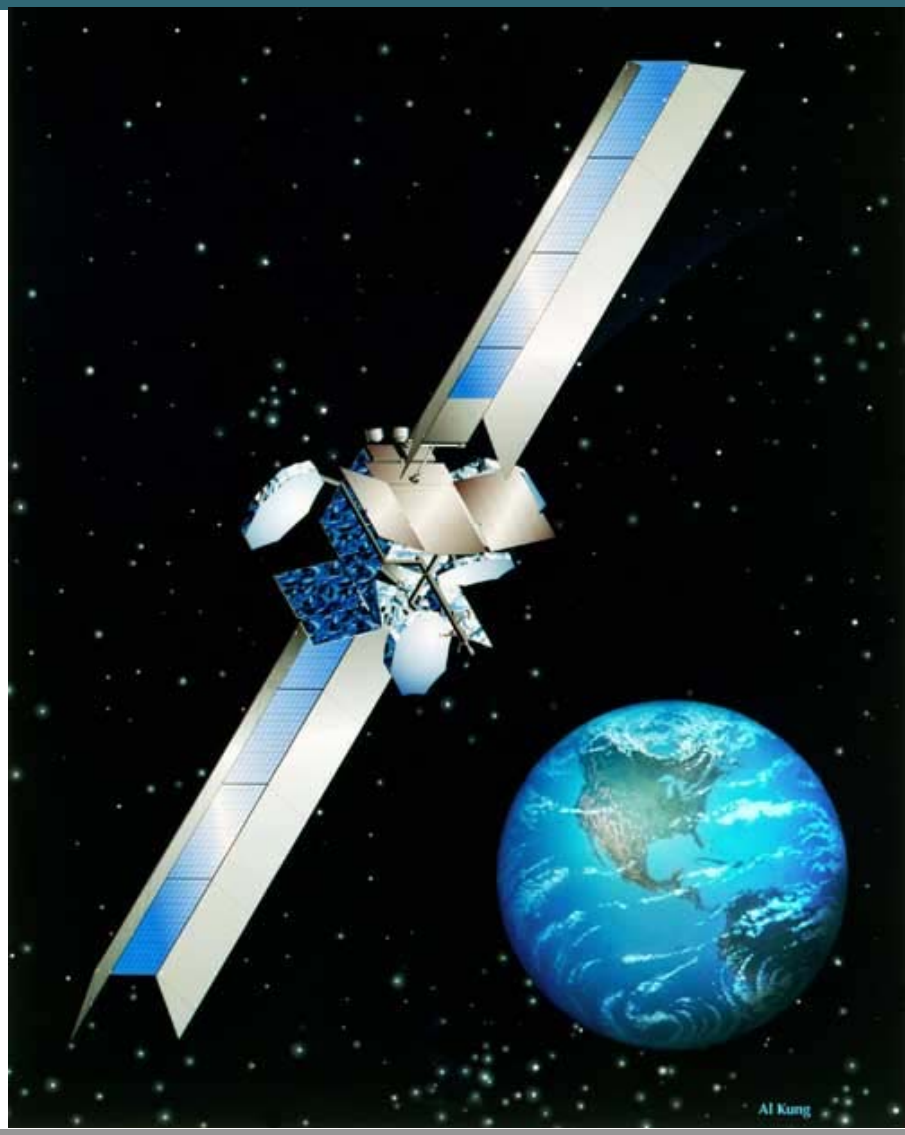
- Commercial, civil and government market segments will transition from technology-driven to customer- and application-driven
- Merged terrestrial and space solutions will drive development of new applications, services and capabilities

    Merged terrestrial and space architectures, with cross-linked satellite constellations (HEO/GEO), will become the blueprint for future missions and capabilities
- New public and private partnerships will drive innovation, lowering the cost of new applications, services and capabilities

- **BUSINESS MODEL**

IP Networking for Next Generation Global Services

- **IP networking extends the terrestrial network to space to deliver next generation global services**
- **IP networking connects widest range of interoperable communications services leading to new, hybrid services**
- **IP networking enables “space to Earth” communications using open standards**



IP and the Internet are *not* TCP

- **Internet has hundreds of protocols running over IP. TCP is just one protocol; many others (DNS, ssh, streaming video) use UDP instead.**
- **TCP performs poorly over satellite. So?**
- **TCP's operating assumptions: Competition; loss is congestion. Backoff ensures fairness.**
- **Once outside our shared terrestrial Internet, TCP's assumptions become less useful.**
- **Other protocols don't share TCP's design assumptions; have different delay limitations.**

Different Scheduling Models

- **Many spacecrafts have just one downlink / connection to the network.**
- **If you operate and control all the payloads on your spacecraft, they don’t have to compete for access to the network.**
- **You can (manually) schedule them one after another to use the dedicated link.**
- **So TCP’s congestion control doesn’t help you; it just gets in the way and makes resource utilization less efficient .**
- **Coarse-grained scheduling model and shared ownership *vs* fine-grained and competition between different owners on the ground.**
- **UDP via static route from Pluto? Why not?**

DTN

TCP/IP systems are poorly suited for adoption in IPN networks where links operate intermittently and over extremely long propagation delay.

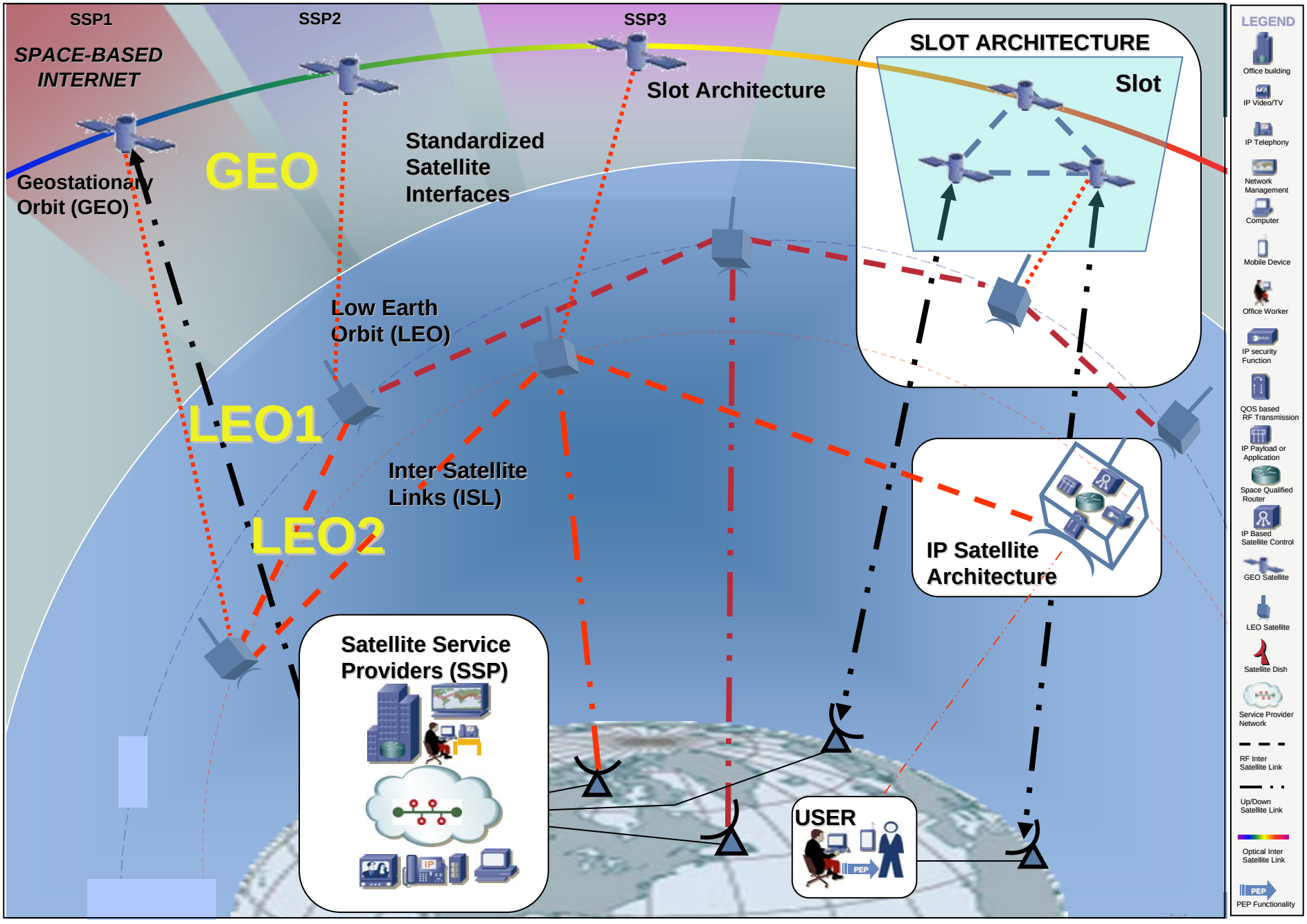
This consideration leads to exploit a network architecture based on an independent middleware, the Bundle Layer, which is the main element of the Delay/Disrupt Tolerant Network (DTN) paradigm.

It is not sufficient to offer reliable and efficient transmission over the IPN Internet, because of the dynamics of the environment under investigation. A more insightful approach is needed.

The key idea for future research is the automatic reconfiguration capacity of the IPN protocol stack obtained by adopting innovative network control strategies.

In this perspective, the idea explicitly fills the control gap in the currently employed communications and networking solutions for IPN networks.

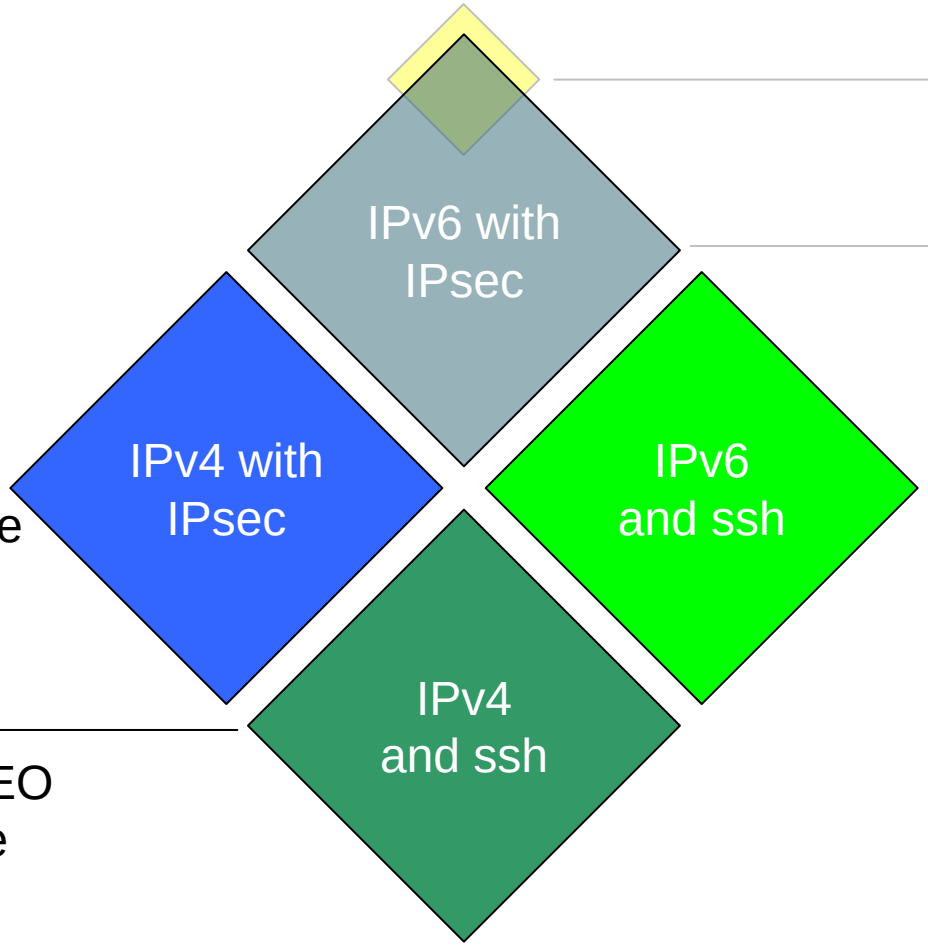
SPACE-BASED INTERNET



The CLEO router experiment

- **Surrey Satellite Technology Ltd (SSTL) is a leading supplier of small satellites and has launched the Disaster Monitoring Constellation – five satellites already IP-enabled.**
- **A commercial Cisco 3251 mobile access router was integrated onto the UK-DMC satellite as a secondary payload.**
- **Launched together with other satellites on Kosmos-3M from Plesetsk into LEO orbit on September 27th, 2003.**
- **CLEO, the "Cisco router in Low Earth Orbit," was tested successfully in a multi-party effort including SSTL, NASA and Cisco. CLEO is still functioning after three years in orbit and two years of testing.**
- **Changed mindsets on what is possible.**

How far can CLEO *[Cisco Low Earth Orbit]* go?
IPv6 and IPsec already in orbit



Future
IPv6+HAIPE, other security methods

Future
IPv6+IPsec together (post-CLEO)

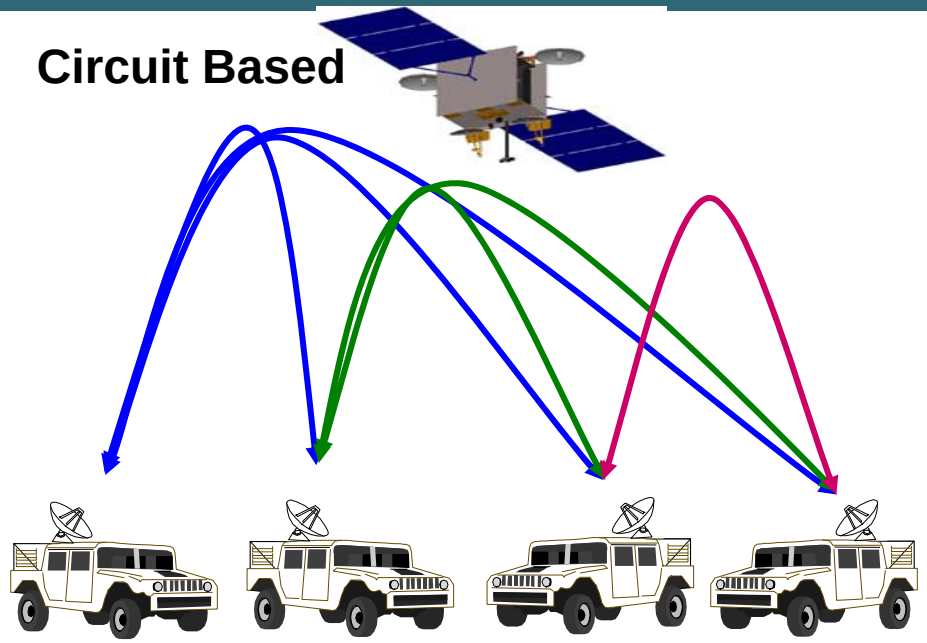
2006
IPv4+IPsec can be tested on CLEO

2006
IPv6 can be tested on CLEO

2004
VMOC tested CLEO with IPv4 in space

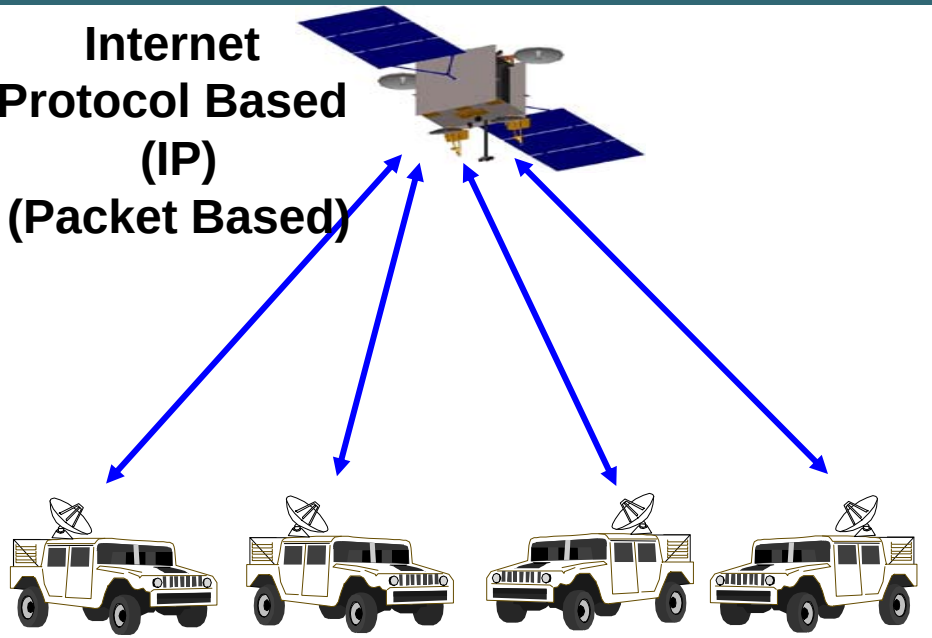
Packet Switching / Routing in Space improves Connectivity and Efficieny

Circuit Based



- **Connectivity:** point to point & multi-point
- **Efficiency:** double hops to connect hubs
- **Flexibility:** dynamic switching; does require prior knowledge of needed connectivity

Internet Protocol Based (IP) (Packet Based)



- **Connectivity:** full mesh connectivity to all GIG users—connects anyone to everyone
- **Efficiency:** 2x-8x improvement over circuits
- **Flexibility:** full routing; does not require prior knowledge of needed connectivity

IP requires fewer resources and simplifies mission planning

New Trends in space communications

How to recognise a trend?

Following trends?
examples of trends

New Trends in space communications

How to recognise a trend?

Following trends?

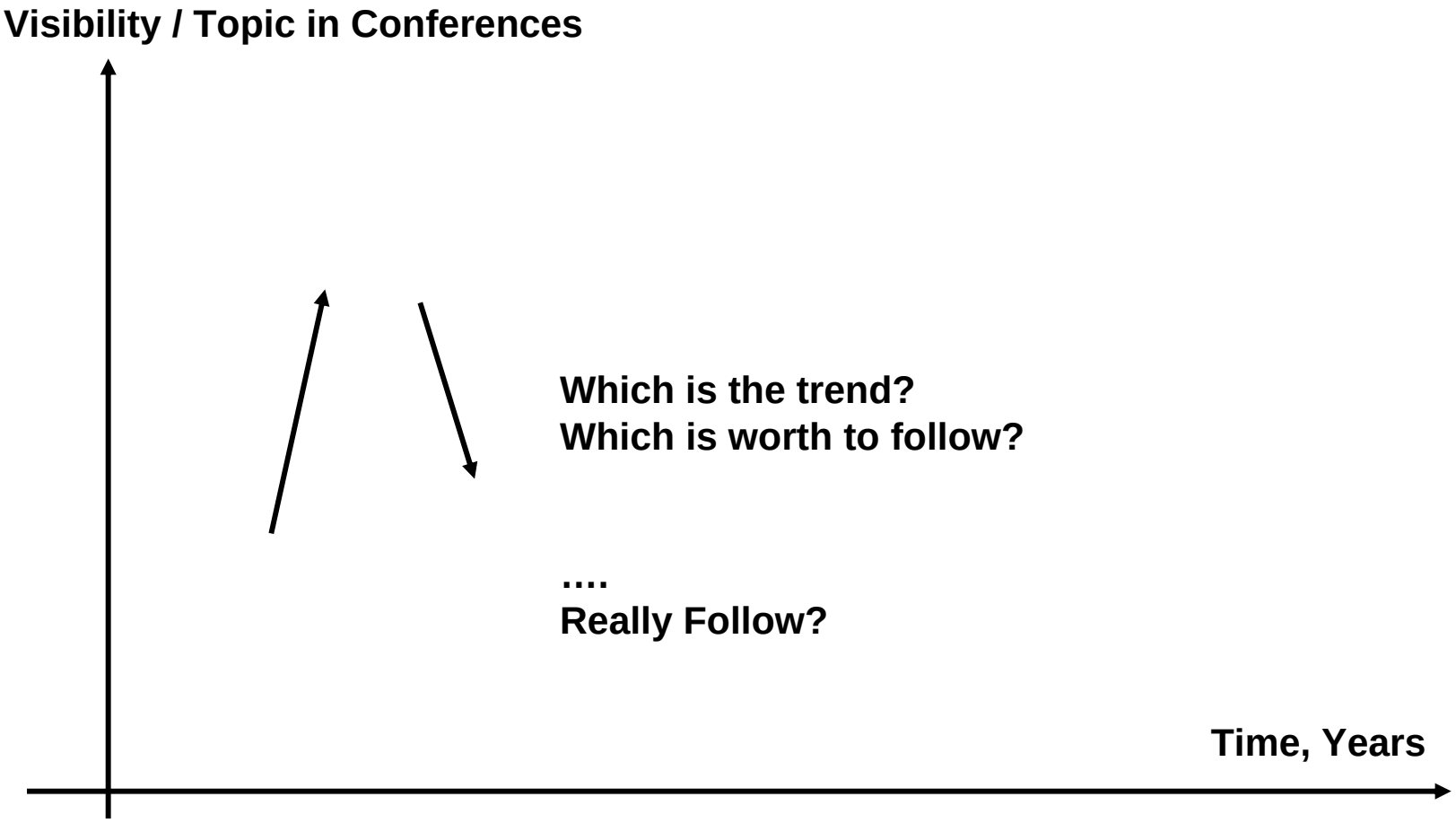
examples of trends

which I do not follow

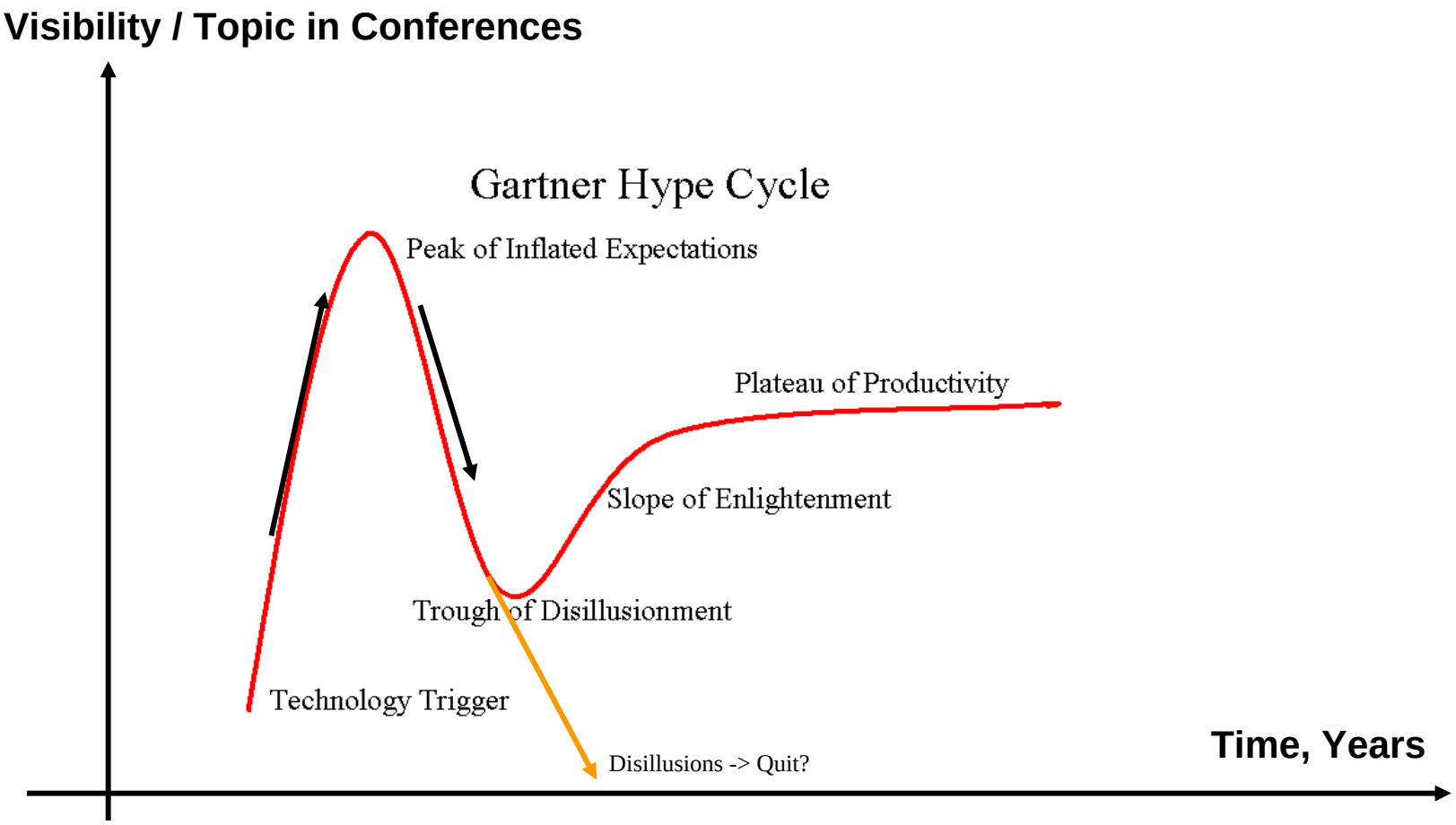
which I follow

which I want to set ☺

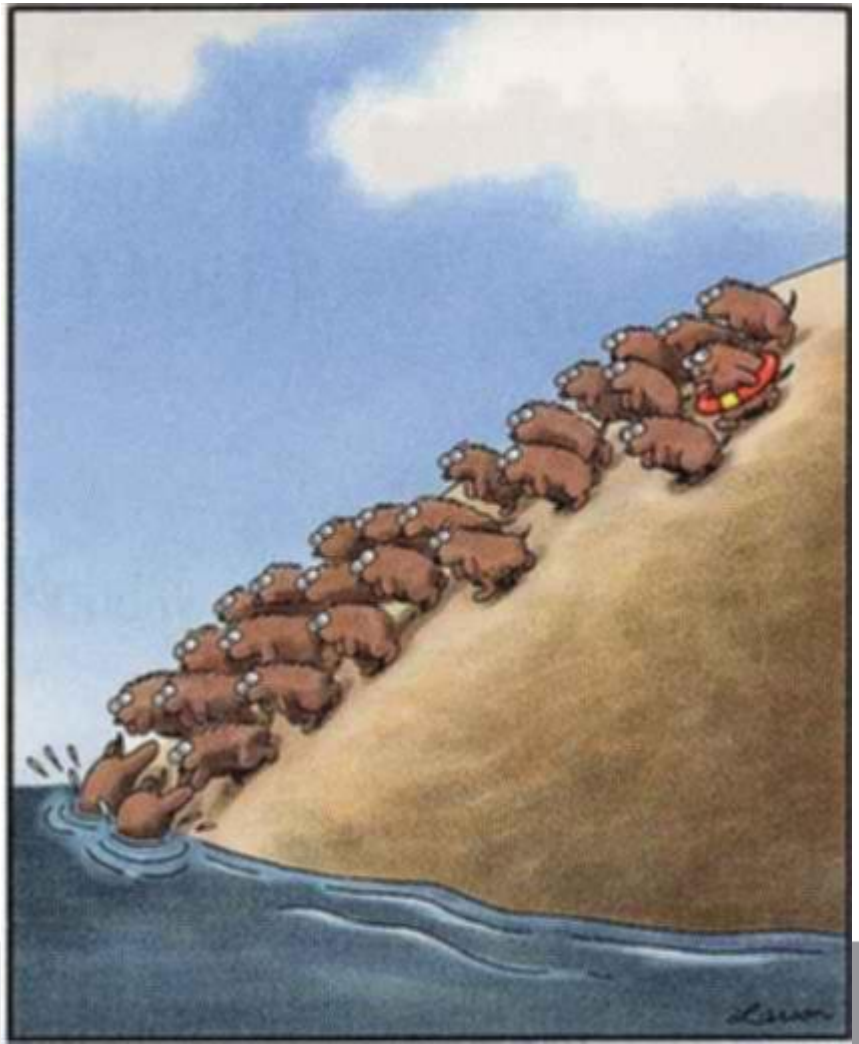
New Trends in space communications



New Trends in space communications

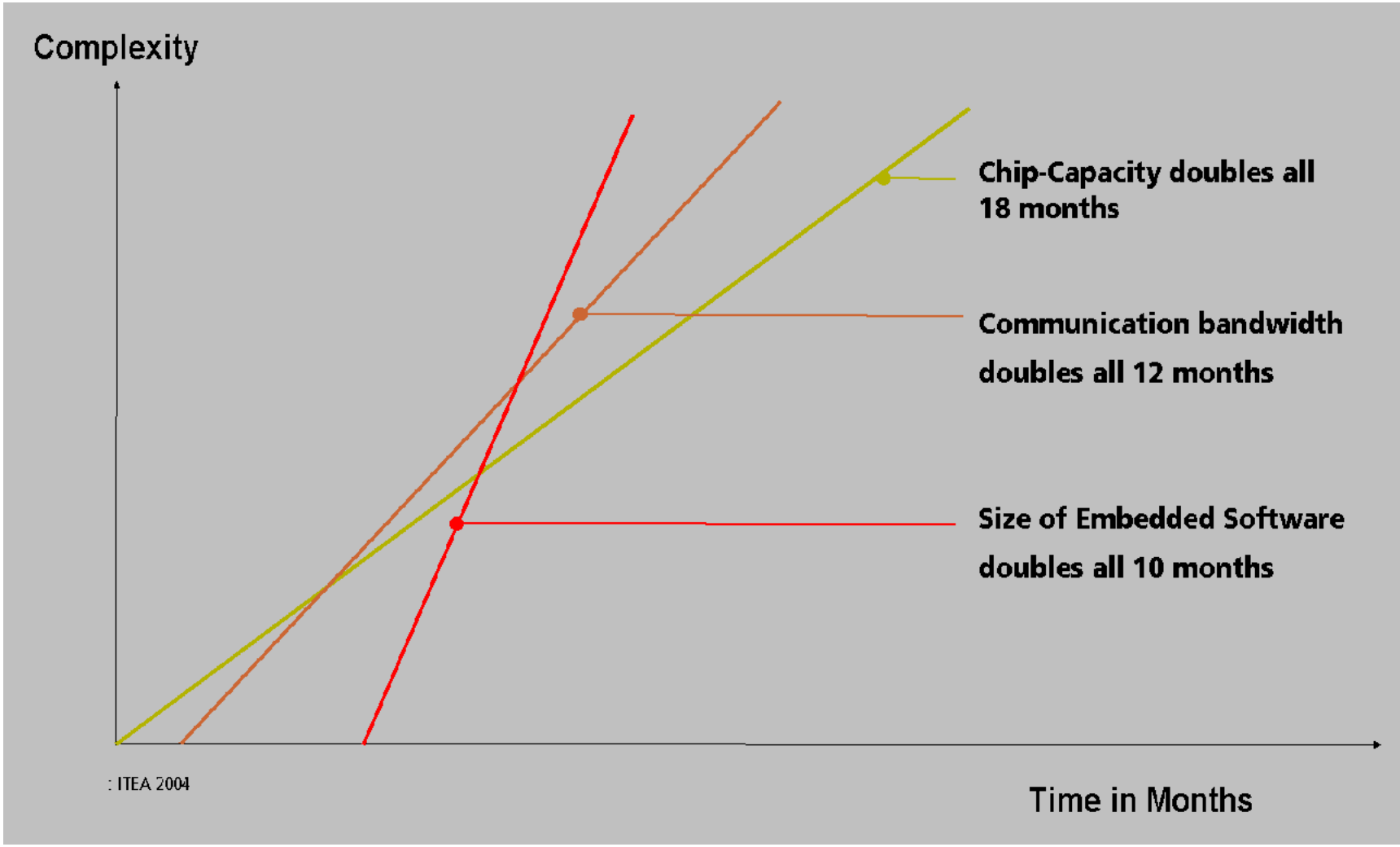


I will show a few trends…
But It is not a good Idea to follow some trend

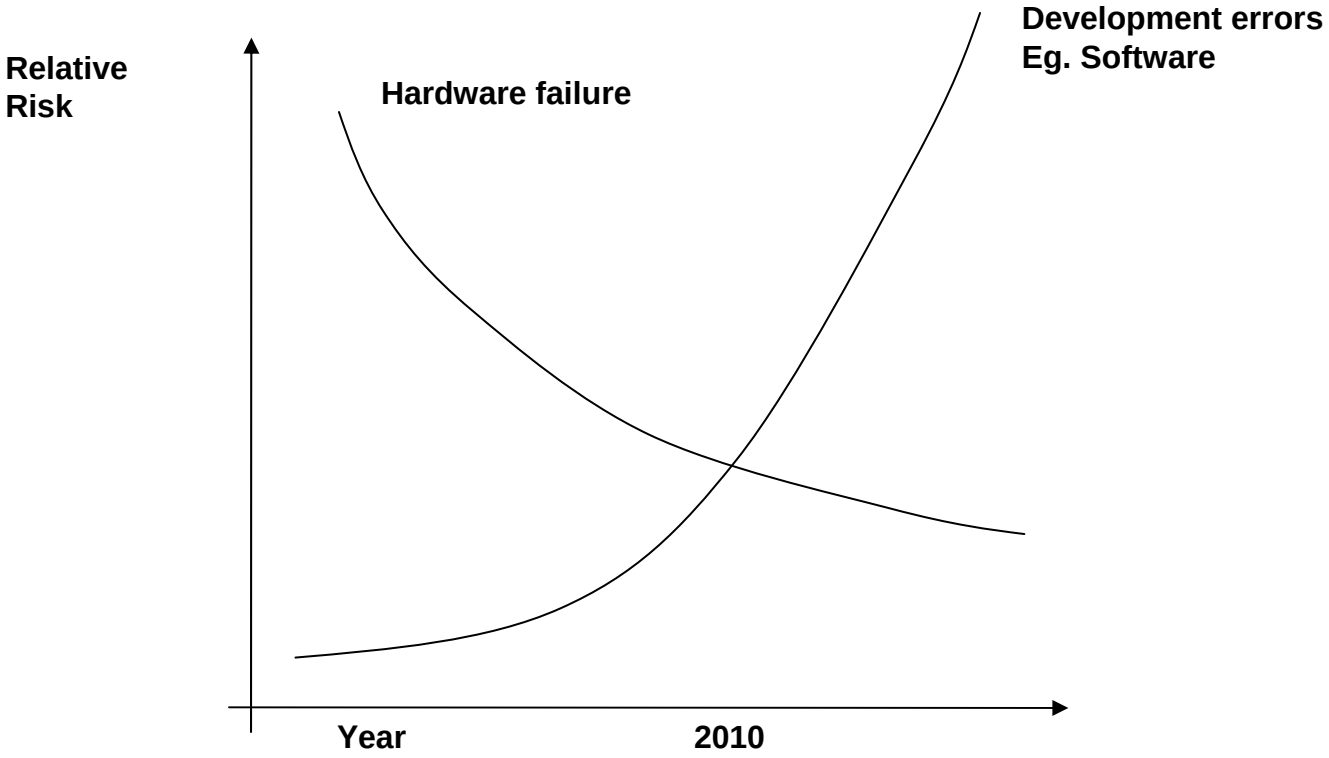


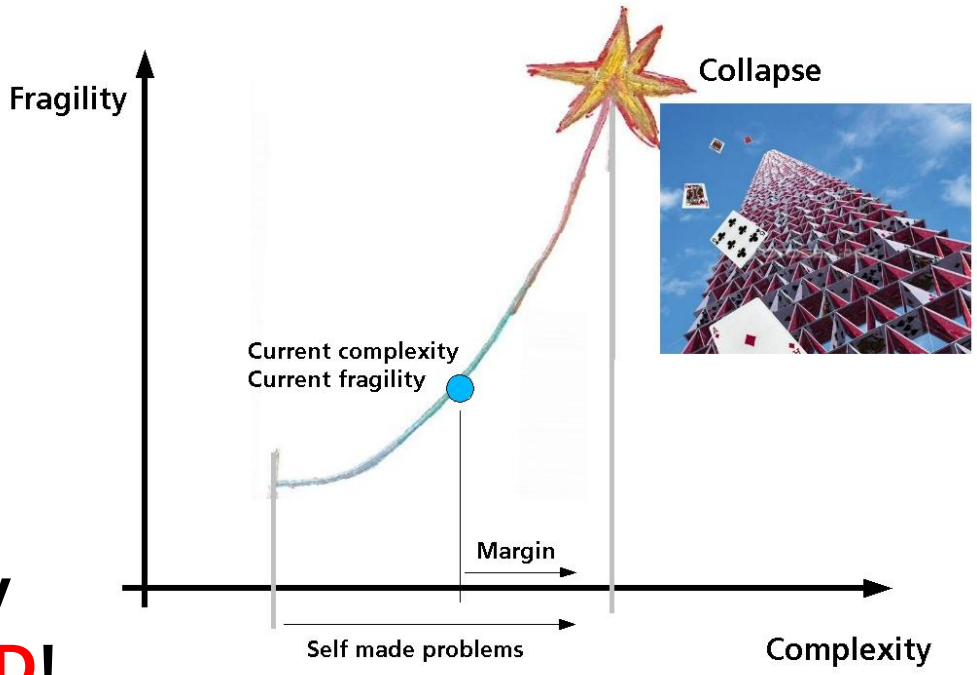
Trends which I do not follow

New Trends in avionics : current trends



Trend: Software goes from hope to main risk!





Old trend:
Increase performance even
If we increase the complexity
-> this will have an END!

Suddenly

My Hope:
Reduce complexity even if we have to accept compromises

Trends which I support (follow…)

New Trends in avionics and communications: current trends

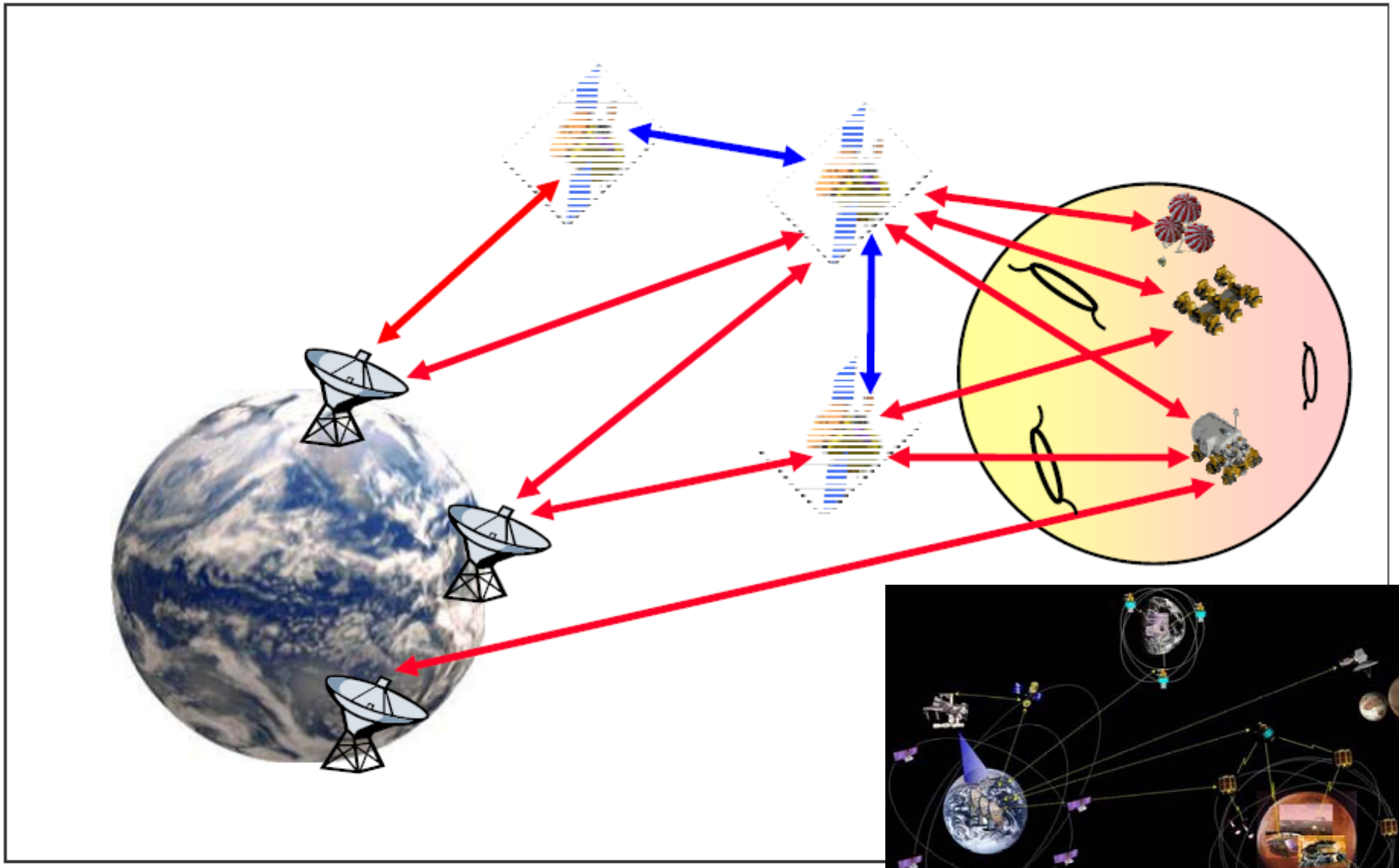
- Higher CPU Performance -> Virtual processors (TSP)

- More Point to Point connections, less busses
- More Serial links, less parallel links

- System as System of Systems:
  Communicating Building Blocks
  -> Distributed control Systems

New Trends in avionics and communications: current trends

- IP in Space (scp, rsh & ssh too?)
- SSAN (Solar System Area Network) & WSSAN (Wireless!)
- Network includes several spacecrafts, ground stations and end users
- -> Radical changes in operations
  from individual manually managed links to multiplexed autonomous links & routing
- -> Link resources are not private for the owner satellite.
  Static pre-planed allocation is not enough any more



- **SISG Reference Scenario**

SISG = Space Internetworking strategy group

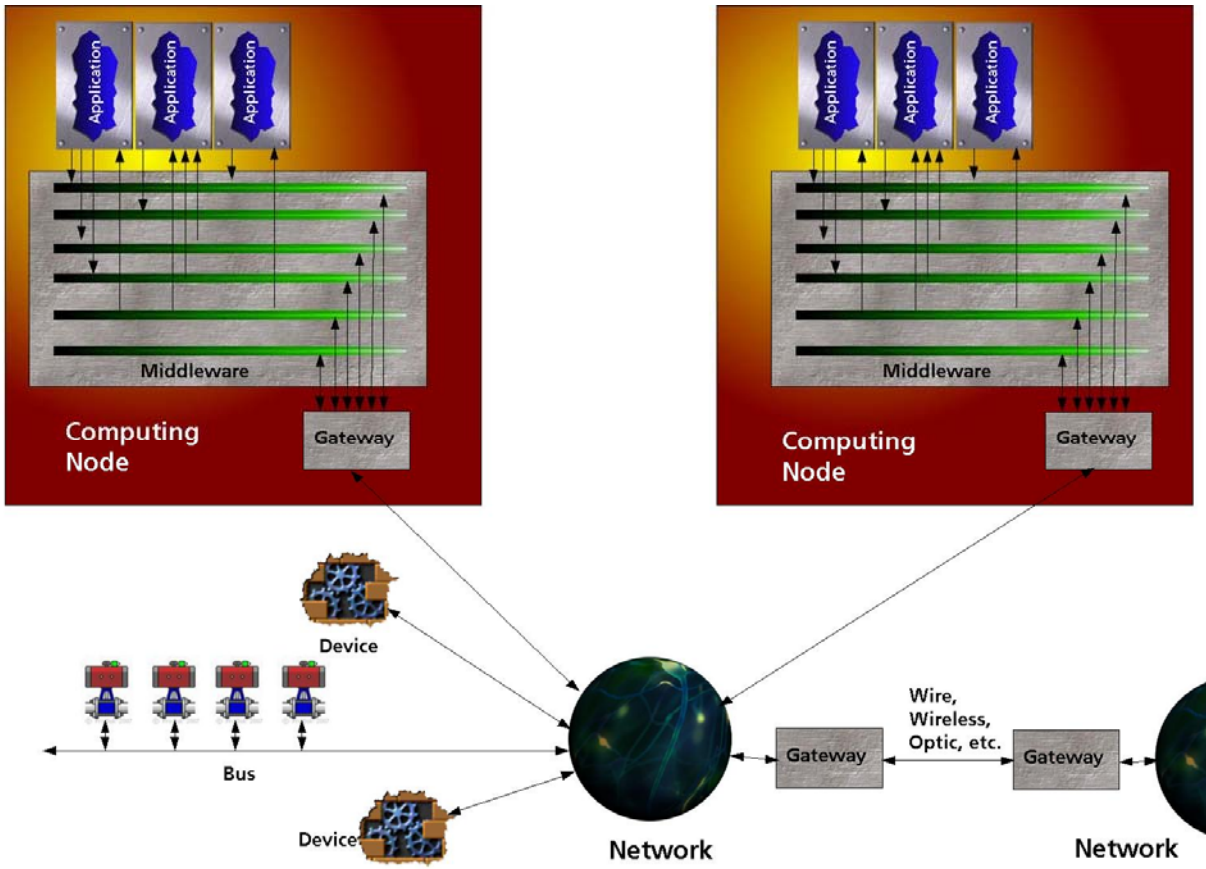
New Trends in avionics and communictions: current trends

- Open Source Era

My own Trend….

Global Network:

Earth, up/down-Link Intra-Spacecrafts, Intra-Component, SW/HW



Tendancies and Challenges in Space Communications

Dr Mark Berrill, ESA Estec, Noorwijk, Netherlands.

Material taken from a presentation by Dr. Julian Santiago Prowald, on behalf of the Telecommunications Department for ECATA Aerospace Business Integration Course (provided by J. Casas, Deputy Head of the Telecommunications Department), ETSI Aeronáuticos, Madrid, 27 Jan 2009

The social impact of Satcoms in the life of citizens

Satcom has an important economic and social value:
Produces revenue, profits, jobs and expertise

- **Turnover on Satellite manufacturing and Launch: 3-4 Billion Euro/year**
- **Turnover on Lease of Space segment capacity : 13 Billion Euro/year**
- **Turnover Ground segment Industry, including consumer products:>30 Billion Euro/year**
- **Turnover on the sale of Satcom based services: >60 Billion Euro/year**

Telecomms remains the mainstay of the Satellite Industry, and Launchers.

139 of 155 satellites launched by Ariane 4 were telecommunications satellites.

20 of 21 satellites placed in orbit by Ariane 5 and Soyuz in 2007 are Telecommunications satellites.

14th August 2007-14th August 2008
9 Launches: ATV and 16 Telecom Satellites

Without Telecommunications satellites the space industry would not be sustainable

(Arianespace ad. Via satellite, Space News. Feb 2008)

The need of an European Data Relay Satellite (EDRS) System

The demand of real time communications between low orbiting satellites or flying vehicles, calls for the development of an operational EDRS System.

Artemis has demonstrated the performance and operational advantages provided by Ka Band and Optical GEO-LEO ISLs, and created a pool of users.

A EDRS system is an infrastructure that will address multiple needs: The most obvious is the provision of real time communication to the GMES System.

Additionally a EDRS System could be made available as a service to a wide range of other customers e.g., ESA's Science, Human space flight, Launchers, or to institutional customers requiring real time data transfer from instruments to ground.

Data Relay Requirements for GMES

- **Continuous Coverage of the up to six Sentinel Spacecrafts of GMES (1A,1B,2A,2B,3A,3B)**
- **High Data Rates up to 600 Mbit/s for ISL and Ka-Band Downlink**
- **(Quasi) Real Time Data Download**