UCL DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING
NETWORKS AND SERVICES RESEARCH LABORATORY

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Towards a Service-aware Future Internet Architecture

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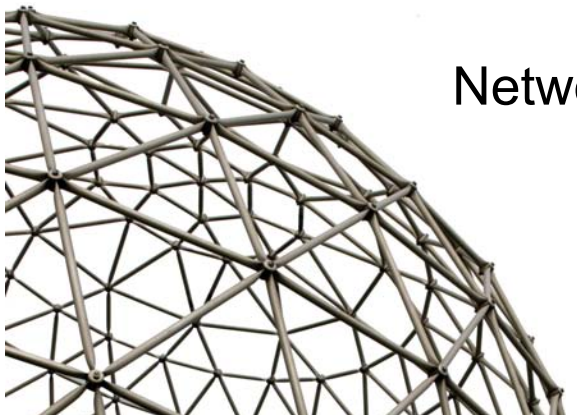
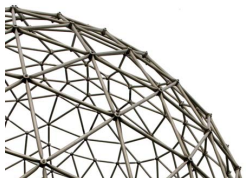


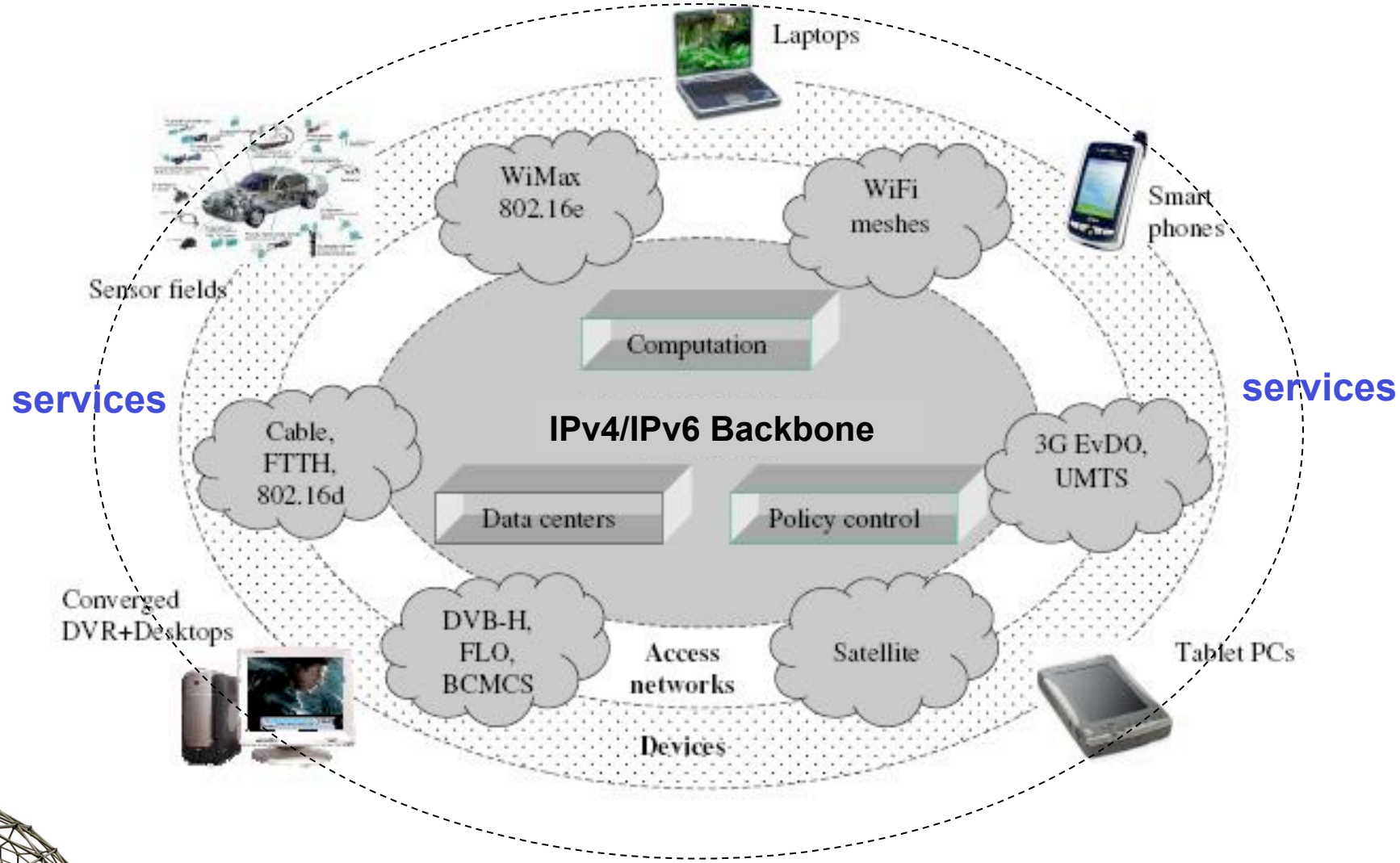
The Current Status

- The Internet plays a central role in our society
  - Work and business, education, entertainment, social life, …
- Victim of its own success, suffering from ossification
  - Technological innovation meets natural resistance, e.g. no deployment of IPv6, no inter-domain multicast, etc.
- Services such as P2P, VoIP, IPTV, emerging ones, pose new requirements on the underlying network architecture
- Big growth in terms of the number of inter-connected devices but slow growth in innovation and new services

- **Solution space:** evolutionary / revolutionary approaches, soft nodes, virtualisation, parallel Internets

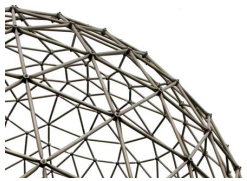


The Emerging Internet



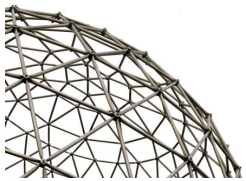
Key Requirements

- Better mobility support
  - Impact on addressing
- More flexible and reliable routing
  - Multi-path as opposed to current single path
- Better service-aware resource control
  - Service-aware mapping of traffic to resources => better QoS
  - Dynamic deployment of new service logic within the network
- Better security, DoS attack and spam protection
  - Possibly other paradigms of identity/presence, e.g. default-off
- Self-management
  - Self-configuration, optimisation, healing, protection



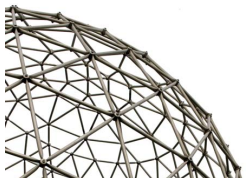
Flexible Addressing and Routing

- Location / ID separation
  - Routing on locators, final delivery based on ID => better support for mobility
- Multi-path routing, paths with QoS characteristics
  - Better resilience, load balancing / use of resources
  - Applications/services can choose based on their requirements – User Selectable Routing
- Let applications to compute end-to-end routes
  - Edge Controlled Routing, new inter-domain approach
  - Choice based on domain quality, reliability, etc.
- Combine content discovery and network-level routing
  - Data-oriented future network architectures



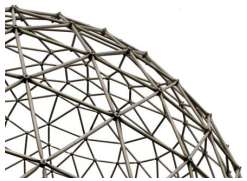
Service-aware Resource Control

- Expected proliferation of services
  - More control to applications/services to choose the right resources
- Resource pooling
  - Treat separate network resources as a single large-pooled resource and share it fairly for achieving better utilisation / QoS
- Service clouds viewing the network as a service
  - Deploy network services in a similar fashion to IT services
  - Treat the network as a computer supporting programs/services

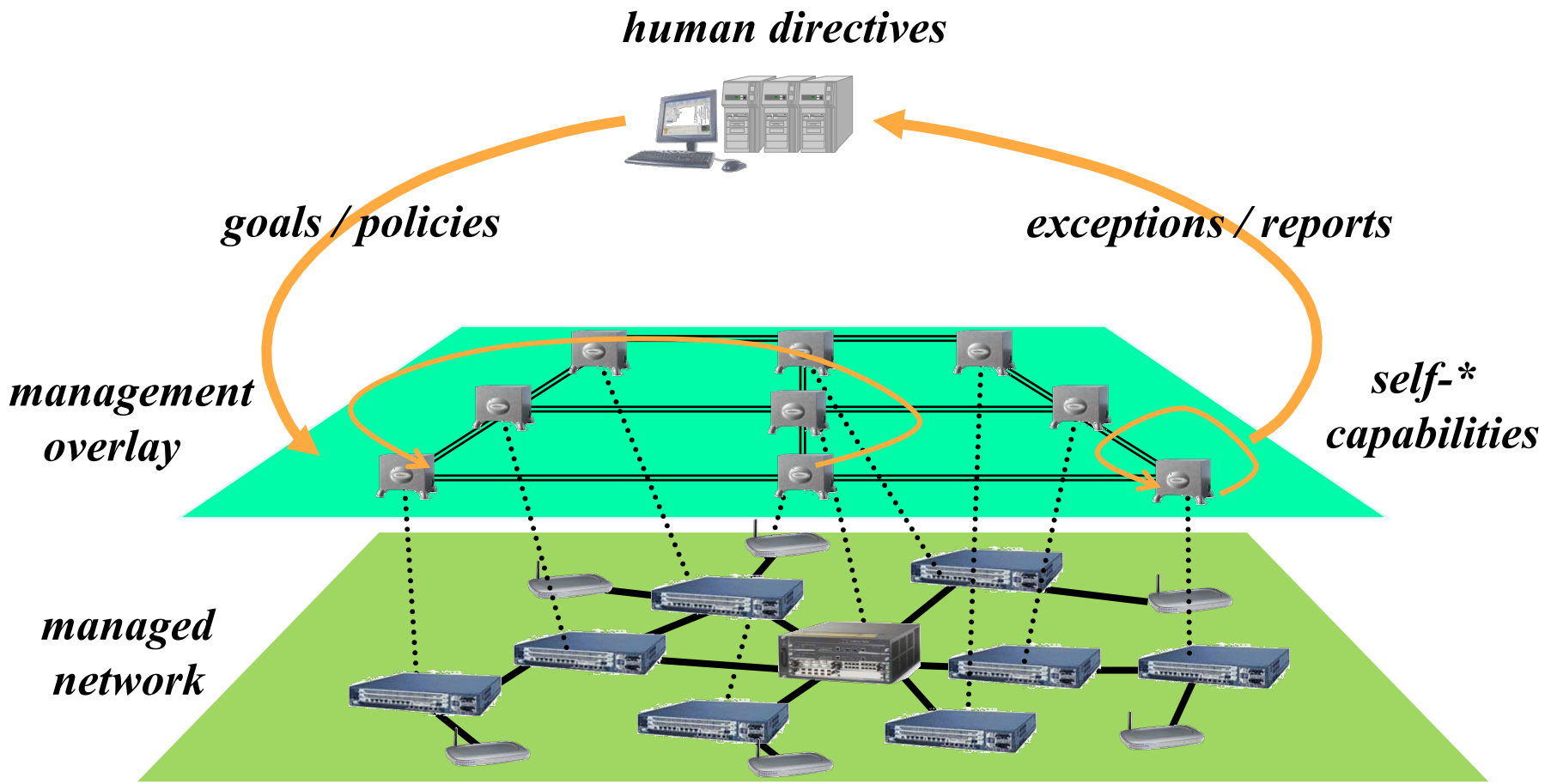


Self-Management

- Support self-* properties so that the network always self-stabilises/operates in a near-optimal state
  - Distributed-management through a set of dynamically-chosen nodes operating in the network – management overlay
  - Collaborative decision making by acquiring knowledge – distributed knowledge plane in the management overlay
  - Orchestration of the built-in management intelligence by setting top-level goals through policies
- Distributed decision making with partial network views
  - Issues of stability and convergence
- "Collapse" of (the majority of) the management plane within the network

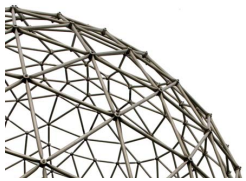


The Management Plane as Part of the Network



Soft Nodes and Programmability

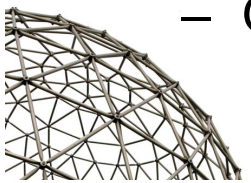
- "Closed" network nodes may lead from one ossification to another
  - Long time for moving to enhanced next generation functionality
- While the forwarding plane is fairly stable (h/w), control, management and service logic (s/w) should be able to change based on well-defined APIs
  - Protection on investment
  - Easier migration to next generation functionality
- Programmability can support soft "open" nodes
  - There has been experience in this area but no industry take-up
  - Essential for rapid service deployment



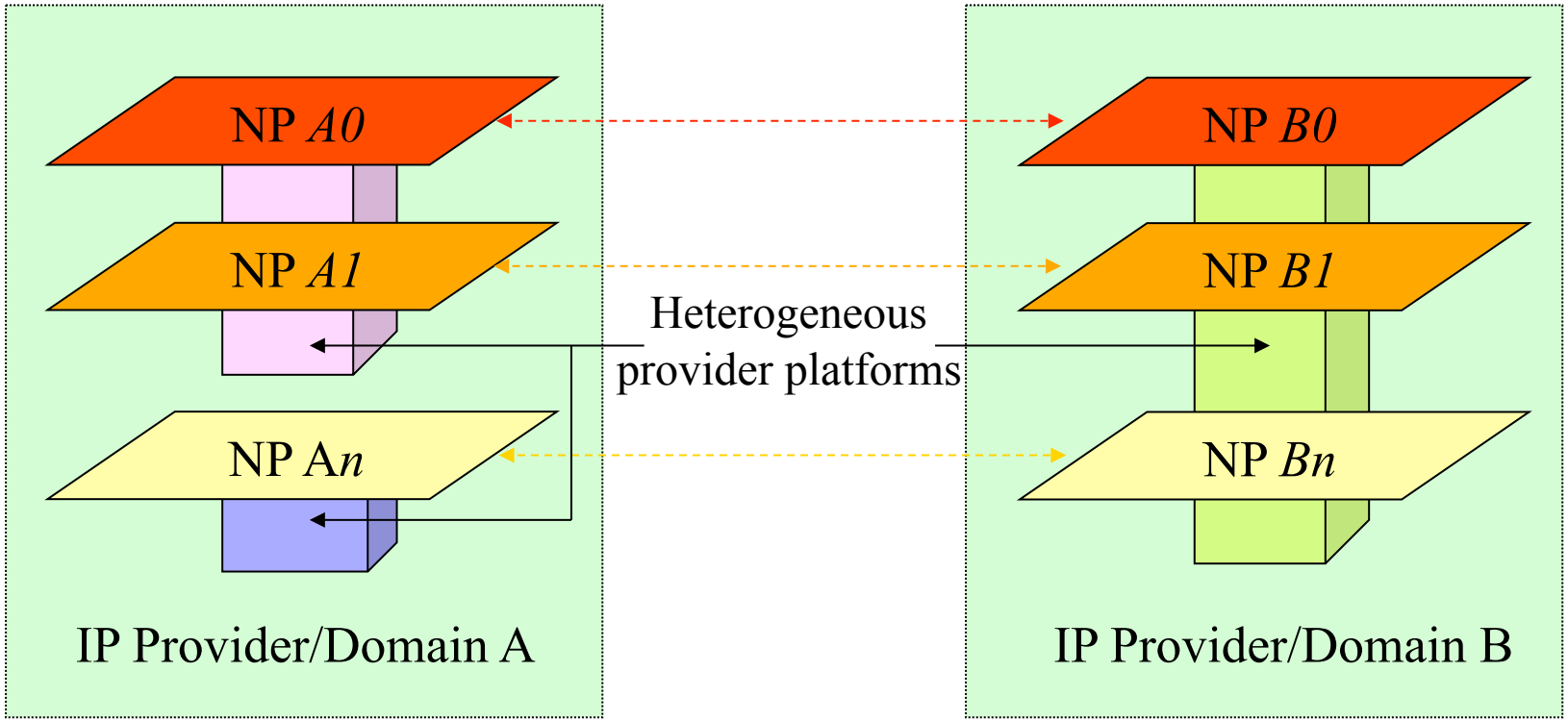
Parallel Internet Architectures

- Can a single next generation Internet architecture support all these requirements?
- What happens with requirements not yet identified?
- How can we guarantee we will not be in the same situation in 20 years time regarding the next^2 generation Internet?

- Possibility: parallel Internet architectures conforming to a meta-architecture that supports parallel instantiations
  - **Virtualisation** will have a key role to play in this context
  - Virtualisation of node (storage/computation) resources and of network (bandwidth/addressing) resources required
  - One instantiation could be the current IPv4-based Internet



Parallel Network Planes / Parallel Internets



- Plane 0: the current IPv4-based Internet
- Domains use their own mechanisms to implement network planes

Summary

- Both evolutionary and revolutionary / disruptive approaches
  - Location / ID separation, resource pooling, multi-path routing with QoS characteristics are evolutionary
  - Edge controllable/computable routes, network-level content-based routing are revolutionary
- Soft nodes and programmability can ease migration, support rapid service deployment and protect investment
- A Parallel Internet Architecture will allow next generation(s) disruptive approaches to be deployed in parallel to the current (and future) legacy