A Vision for the Future Internet

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Outline

- On Fundamentals
  - Still valid?
- On Impairments
  - Who hasn't experienced them?
- On Promises
  - Design for tussle? A Remedy?
- On Visions
  - Tussle networking, just one…

- …and how could we know?
  - A glimpse of the crystal ball

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Re-Thinking Fundamentals

What’s been true is no longer….

Fundamentals of the Internet Design

- Collaboration
  - Reflected in forwarding and routing
- Cooperation
  - Reflected in trust among participants
- Endpoint-centric services (mail, FTP, even web)
  - Reflected in E2E principle

-> IP, full end-to-end reachability

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Reality Today in the Internet

- Phishing, spam, viruses
  - There isn't trust no more!
- Information-centric services
  - Web, sensors, RSS feeds, even voice
  - Do endpoints really matter?
- Endpoint-centric services in decline
  - Even endpoint-centric ones moved towards information retrieval through CDNs

-> IP with middleboxes breaking E2E & significant decline of trust in current Internet

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But There is Still Lots of Money in The Internet!

Suppose the spammer sends out 2,000,000 emails.

- Of that, 5% (100000) go to legitimate email addresses.
- Of that, 5% of the people receiving the phishing email respond (5000).
- Of that number, only 2% are foolish enough to actually submit their personal information (100).
- According to FTC, average phishing loss is about $1,200.

-> A phisher can make $120,000 (with $200 tools investment)!

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How About the Fundamentals Though?

- What stood at the beginning
  - Collaboration
  - Cooperation
  - Endpoint-centric services

  does not seem enough

- What about:
  - Trust?
  - Information centrism?
  - Validity of E2E?

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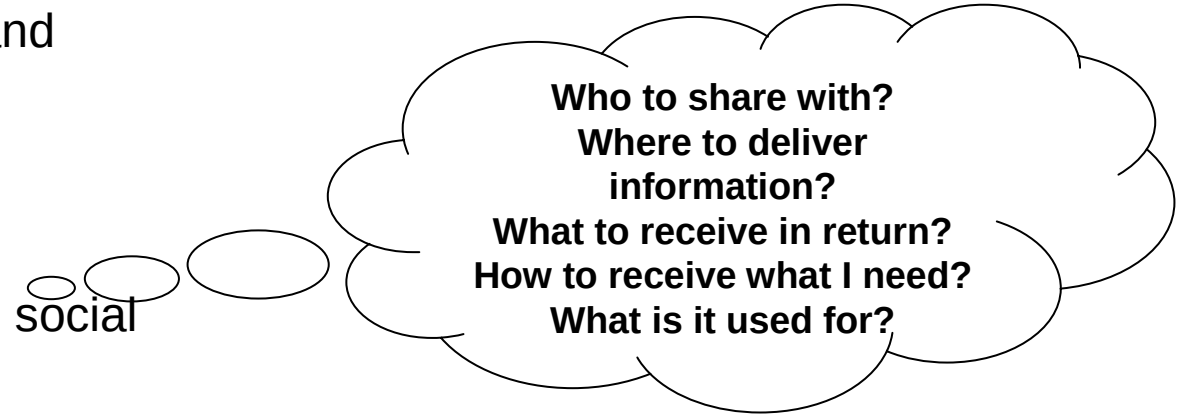
Impaired Networking: The Reality of Today's Internet

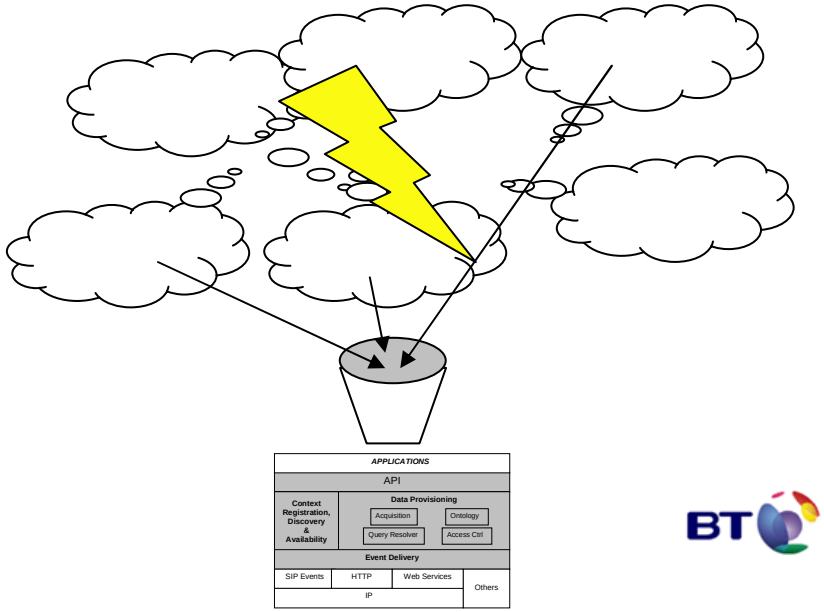
Problem Space: Communication and Its Surrounding Concerns

Communication is essentially about production, retrieval and consumption of information

Information is delimited by concerns, e.g., representing social structures



Concerns of individuals, organizations, communities, and societies could lead to conflicts (tussles)



Concerns are represented in systems & solutions as constraints

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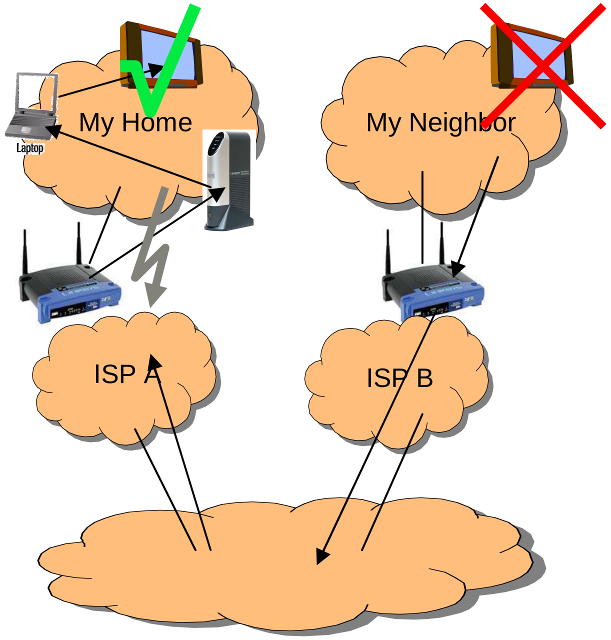
Problem Today: Impaired Networking

Example:

Showing my photos at my neighbour's house



Problem here:

- End users don't comprehend the concept of domains & network boundaries
- Information adheres rather badly to network topology boundaries
- Intentions of users not well exposed to solution, conflicting with defined security concerns

Fundamental Problem

Communication is impaired by implicitly embedding concerns into architectures & solutions

-> designing an architecture is a way of mediating conflicting concerns of players

-> conflict resolution at design phase

Observations:

- Lock-in of different kinds, e.g., single *device lock-in*, *operator lock-in*, *frequency lock-in*, *network lock-in*, *identity lock-in*
- Appearance of parallel, yet often similar architectures that are difficult or impossible to navigate across
- Increase of complexity and maintenance of parallel architectures

Design for Tussle: A Remedy?

- Laid out principles for architecture design that would allow for tussle to commence
  -> architecture-driven view

- Principles relatively informal
  -> hard measures of ‘successful tussle design’ missing (often criticized)

- Separation of concerns should be possible
  -> hard to specify

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Tussle Resolution in Reality

- A potential **tussle** in the marketplace finds its entry into the architectural solution that is being deployed by a set of nuts and bolts in the technical solution
  - Example: firewalls

- Tussles are often incorporated into architectural solution after the design
  - Evolutionary extensions (firewall again)

Result:

- Architectural rigidities through feature interactions of the nuts & bolts
- Parallel architecture deployments, each representing a set of tussles

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A Vision for the Future: Tussle Networking

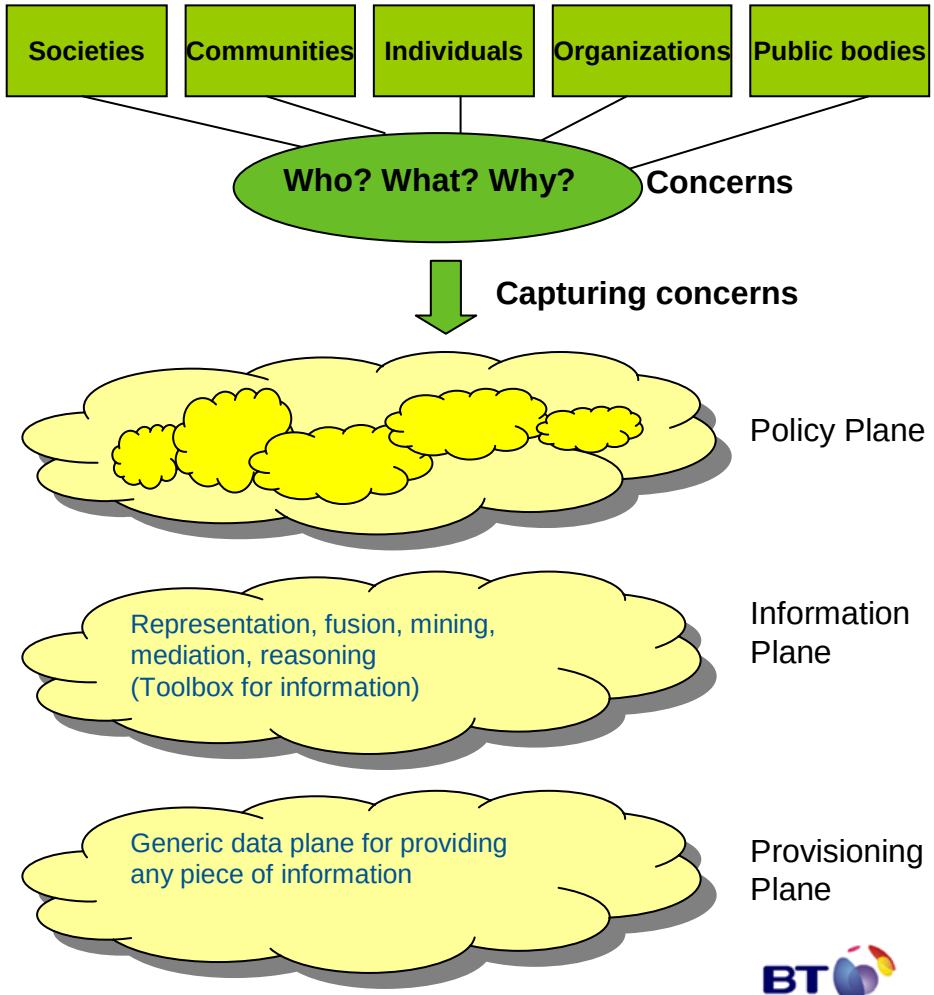
Bend in runtime rather than through design

Vision for Tomorrow: Tussle Networking

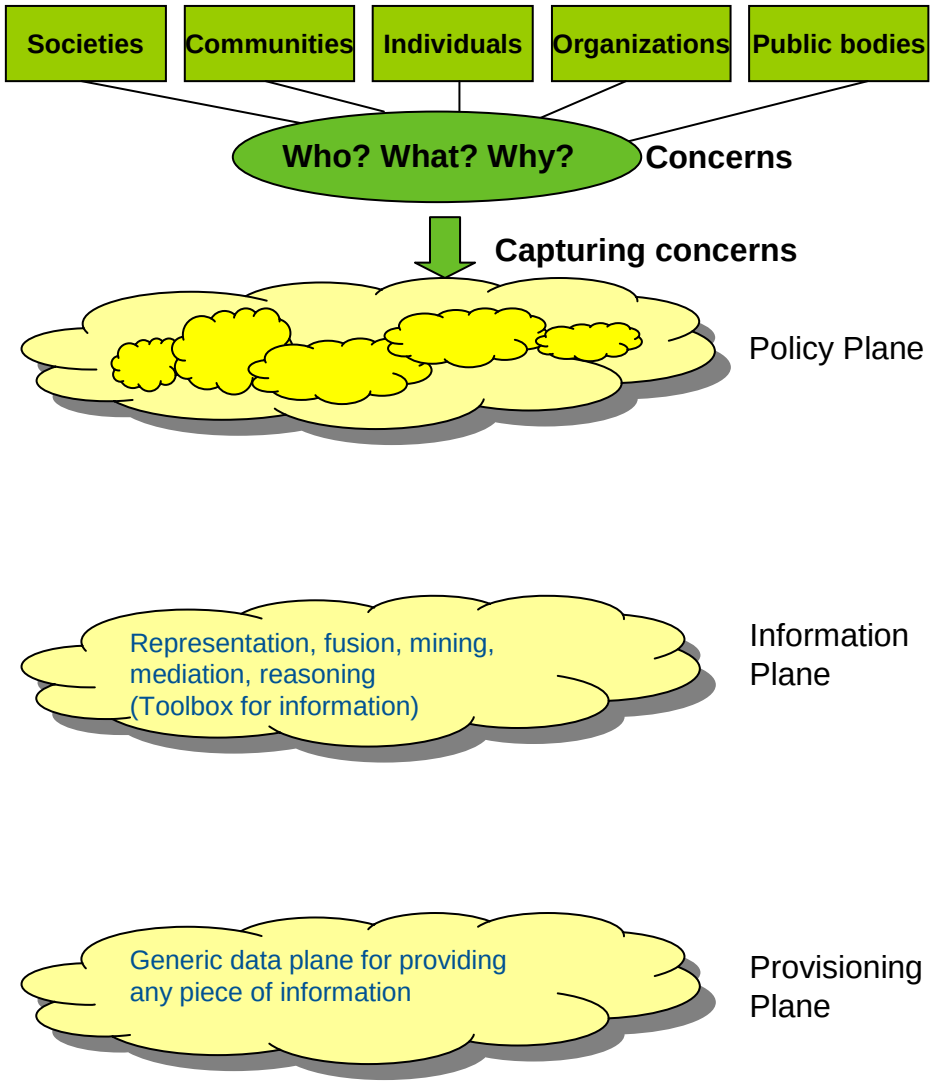
Expose concerns as explicit policies, executed within a single architecture

-> Minimize parallel architectures through conflict resolution at runtime

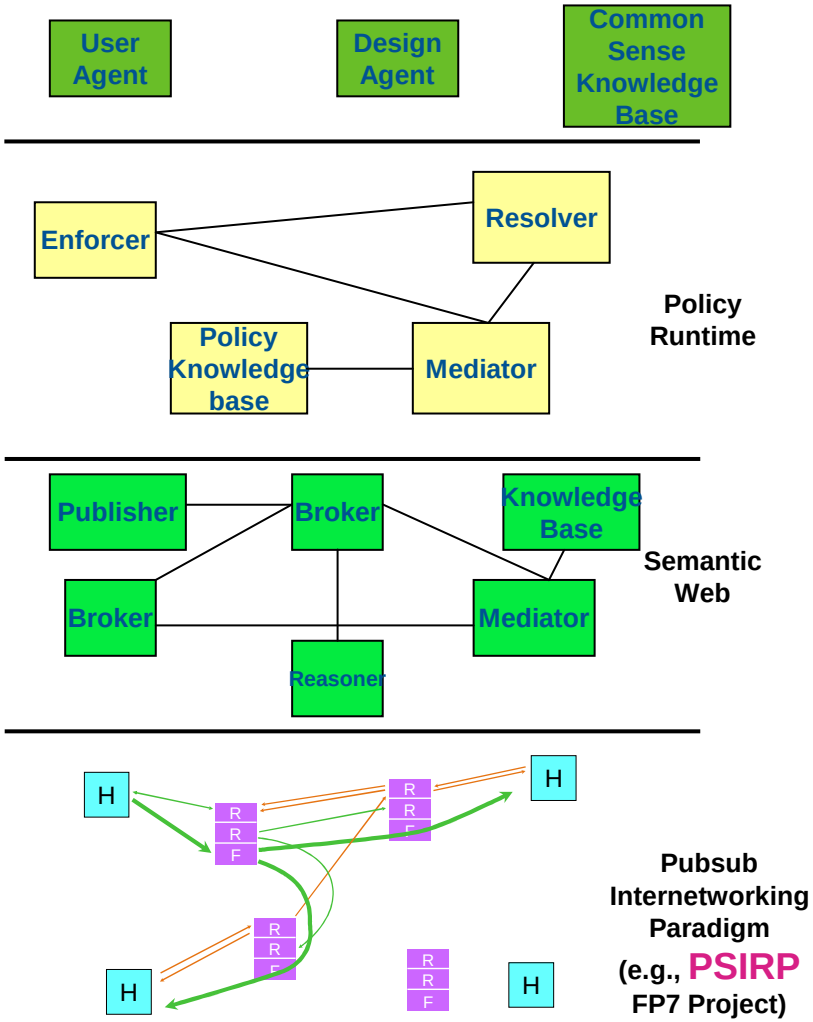
- **Base network notion entirely on information**
  - ***Networks* are build around information scopes, governed by policies**
- **Resolve conflicts through policy mediation, negotiation & enforcement**
  - **Knowledge of social structures can help here**
- **Instantaneous reconfiguration according to needs**



A Post-Modern World: The Tussle Internet



Architectural Vision



Architectural Implementation

Understanding and Navigating in Future Design Options

The Duality of Architecture Design & Business Modelling

Architecture Design and Business Models: Two Sides of the Same Coin

- Where to place control points?
  - …and where not?
- How flexible is my architecture solution?
- What business does it enable?
  - and which ones it does not (and should not)?
- What to place on what layer?
- How to enable generality?
- How to maximize utility?
- …

- How survivable is my business?
- What strategy will sustain my business?
- Where can I extract value in my offering?
- What implements (architecturally) my strategy best?
- What makes my strategy worth trying?
- Who to partner with?
- How to be better than my competition?
- …

Regulatory and organizational structure domain are left out

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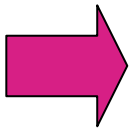
“Classic Design”: Architecture defines business or vice versa

Architecture -> Business:

- IP hourglass -> horizontalization of telco industry

Business -> Architecture:

- Desire to own customer data -> centralized lookup



An architect is a business developer and vice versa!

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Desired: A Framework that Tightly Combines Architectural Design and Business Modeling

- Assume we had a framework that would combine architectural design and business modeling

- Assume that we had a tool that would allow for evaluating success and failure of business models and architectural designs

RESULT: Implement *Design for Tussle* as a duality of strategic business planning and architectural design with measures for success and failure of propositions!

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Strategic Planning Turns Into Architecture Evaluation

The duality of design and business model allows for evaluating architectures and their enabled business(es) in the same time

=> Evaluate system designs in the light of different strategic scenarios, answering questions like

- How to do better than your competition?
- What makes a strategy worth trying?
- Is it better to open a closed system or to close an open system? And when?
- What makes my architecture superior?
- When will my architectural solution ‘break’?

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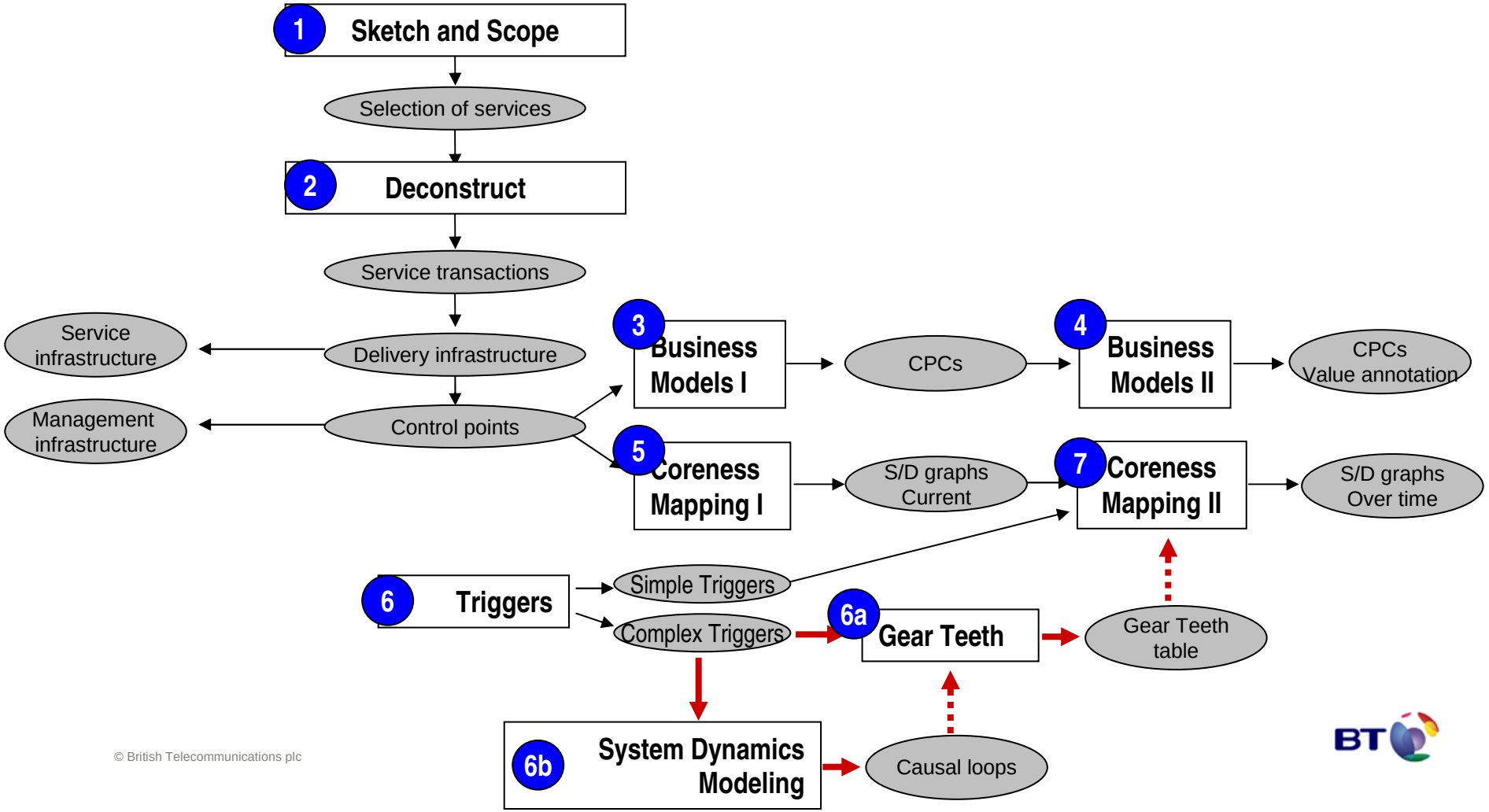
We have: A (First) Framework that Combines System Design & Business Modelling

Value Chain Dynamics Toolkit (CFP VCDWG)



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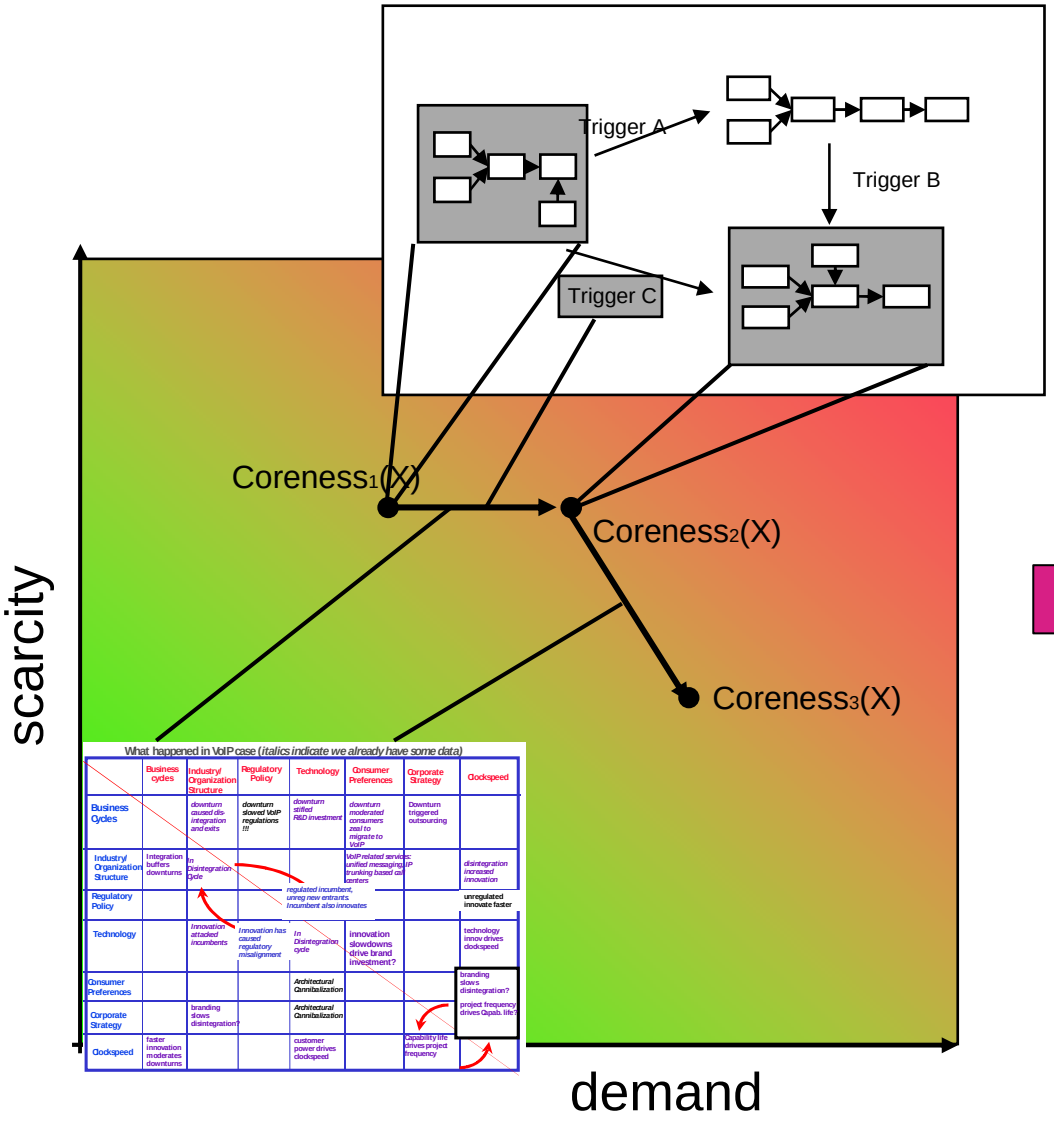
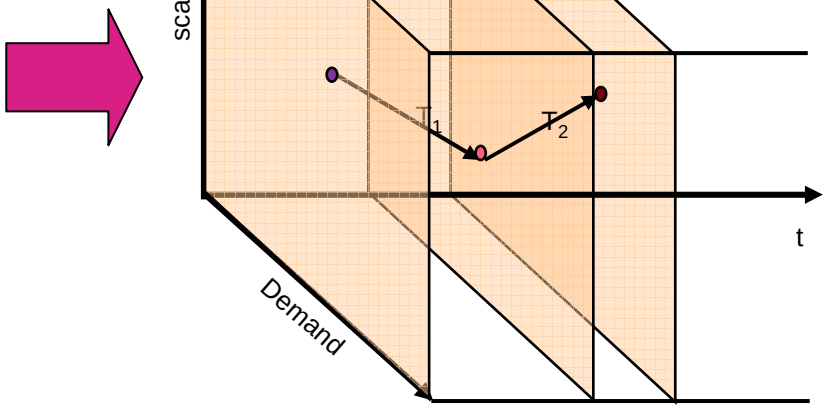
We have: A (First) Framework to Evaluate Success & Failure Scenarios for Business Models





…and Tussle Networking in this?

Recap of Tussle Networking: Design for Tussle of (parallel) architectures moves towards an execution model for tussles within the network

With this: The system design framework becomes a **central** policy planning tool that helps mediating tussles within the system (in runtime!)

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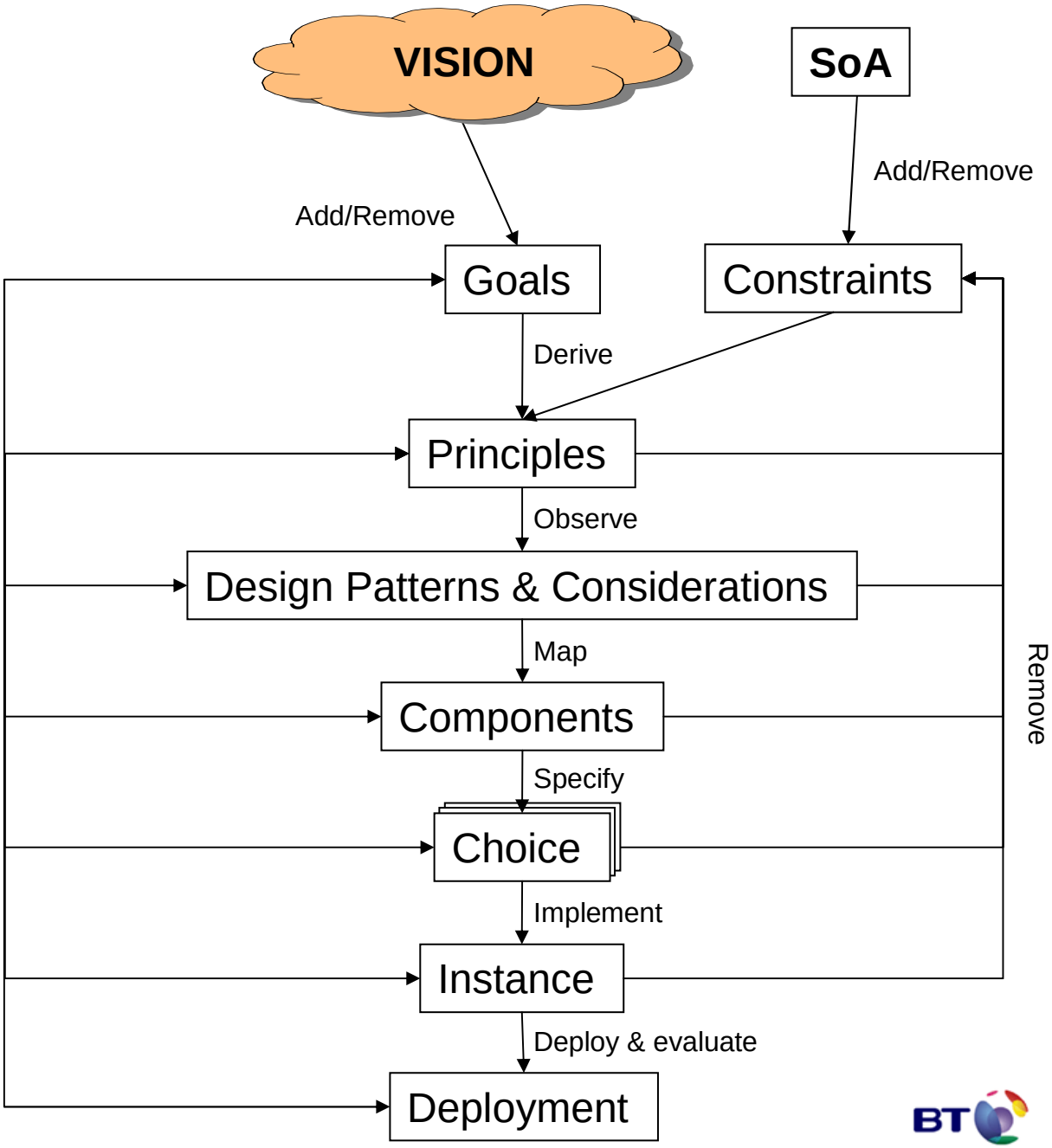
Top-Down or Bottom-Up?

Approach in PSIRP (FP7 project):

- Combination of both
- move away from strict top-down requirements engineering
- simultaneous design & implementation
- constantly question & but also rationalize findings

=> more of a Darwinian approach



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Conclusion

- Predicting the future is hard!
  - Designing for all options of future services is harder than ever, certainly harder than at the beginning of the Internet!
- A vision is required that allows for the co-existence of old and new futures!
  - Cannot afford constant re-design and re-deployment!
  - Need tools to evaluate options and even predict success/failure!

-> Provided a first glimpse of such vision that allows us to go for this future!

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