Complexity Framework Discussion

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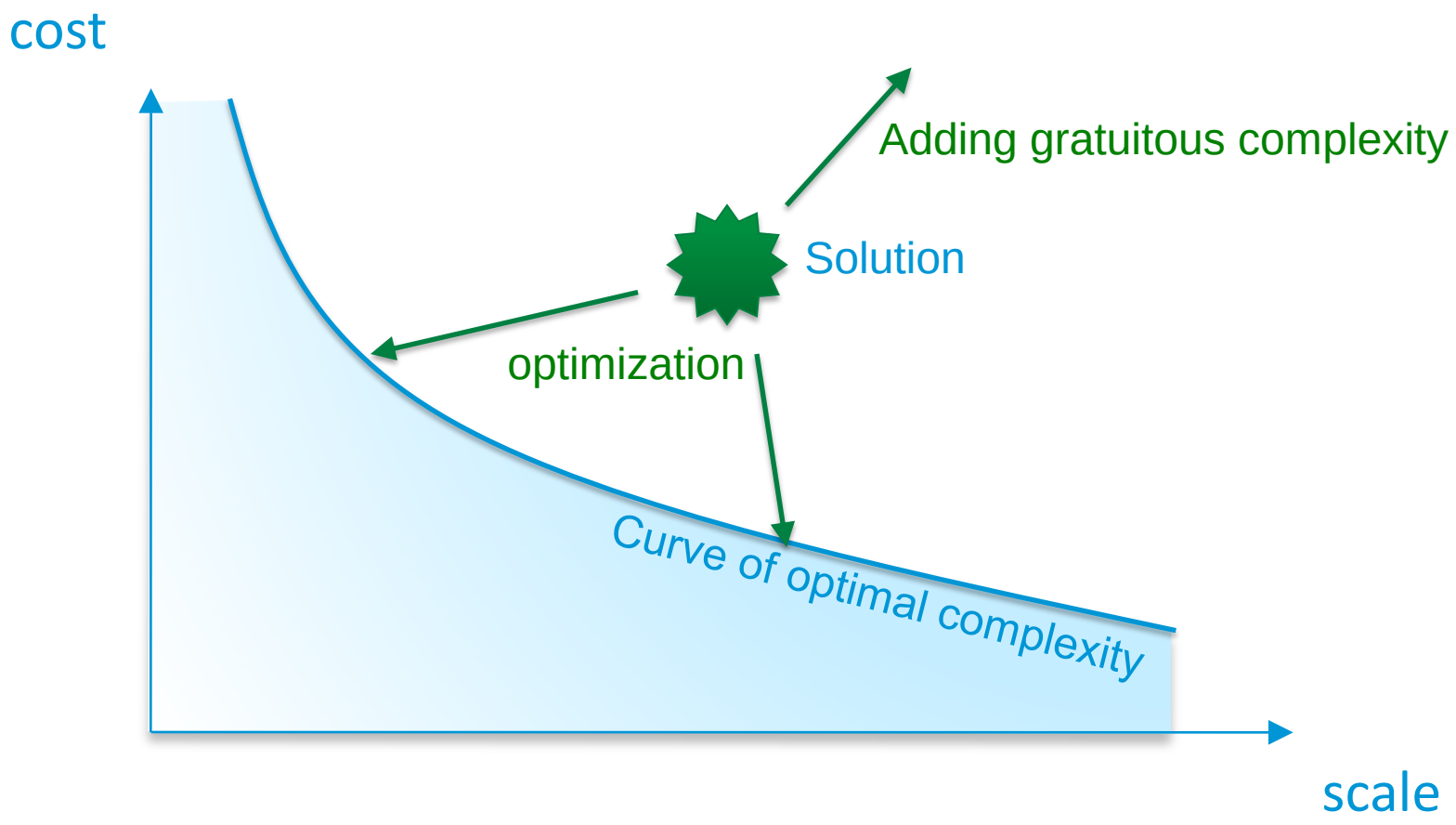
Summary

- Each network has N design criteria / metrics
  - Explicit: Cost, bandwidth, delay, ...
  - Implicit: Extensibility, de-bug-ability, ...
- We see those criteria are axes in an N-dimensional graph
  - Each network can be mapped into this space
- There are tradeoffs: You can’t optimise all axes

Tradeoffs and Complexity



Source: John Doyle

Obvious Metrics

- Cost
  - How much does the network cost to build (capex) and run (opex)
- Bandwidth / delay / jitter
  - Traffic characteristics between two points (average, max, ...)
- Configuration complexity
  - How hard to configure and maintain the configuration
- Susceptibility to Denial-of-Service
  - How easy is it to attack the service
- Security (confidentiality / integrity)
  - How easy is it to sniff / modify / insert the data flow
- Scalability
  - To what size can I grow the network / service

Other Metrics

- Extensibility
  - Can I use the network for other services in the future?
  - Positive example: IP
  - Negative example: Traditional telephony
- Ease of troubleshooting
  - How hard is it to find and correct problems?
  - Negative example: Manually configured IPsec overlay networks
  - Positive example: Dynamic IPsec overlay networks
- Predictability
  - If I change a parameter, what will happen?
  - Negative example: Configuration
- Clean failure
  - When a problem arises, does the root cause lead to deterministic failure
  - Negative example: Coax Ethernet; browser certificate problems
  - Positive example:

Metrics from draft-retana-network-complexity-framework-00

- Control Plane State verses Optimal Forwarding Paths (or it's opposite measure, stretch)
- Configuration State verses Failure Domain Separation
- Policy Centralization verses Optimal Policy Application
- Configuration State verses Per Hop Forwarding Optimization
- Reactivity verses Stability

New Framework Draft Outline

1. Introduction
2. General Considerations
   - The Behavior of a Complex Network
   - Robust Yet Fragile
   - The Complexity Cube
   - Related Concepts
   - Technical Debt
   - Layering considerations
3. Tradeoffs
4. Structural complexity
5. Components of complexity
   - The physical network
   - State in the network
   - Churn
   - Algorithms
6. Location of Complexity
   - Topological Location
   - Logical Location
   - Layering Considerations
7. Dependencies
   - Local Dependencies
   - Network Wide Dependencies
   - Network External Dependencies
8. Management Interactions
   - Configuration Complexity
   - Troubleshooting Complexity
   - Monitoring Complexity
   - Complexity of System Integration
9. External interactions
   - User Interactions
   - Interactions on End Systems
   - Inter-network interactions
10. Examples