

Gray Networking

a step toward next generation computing networks

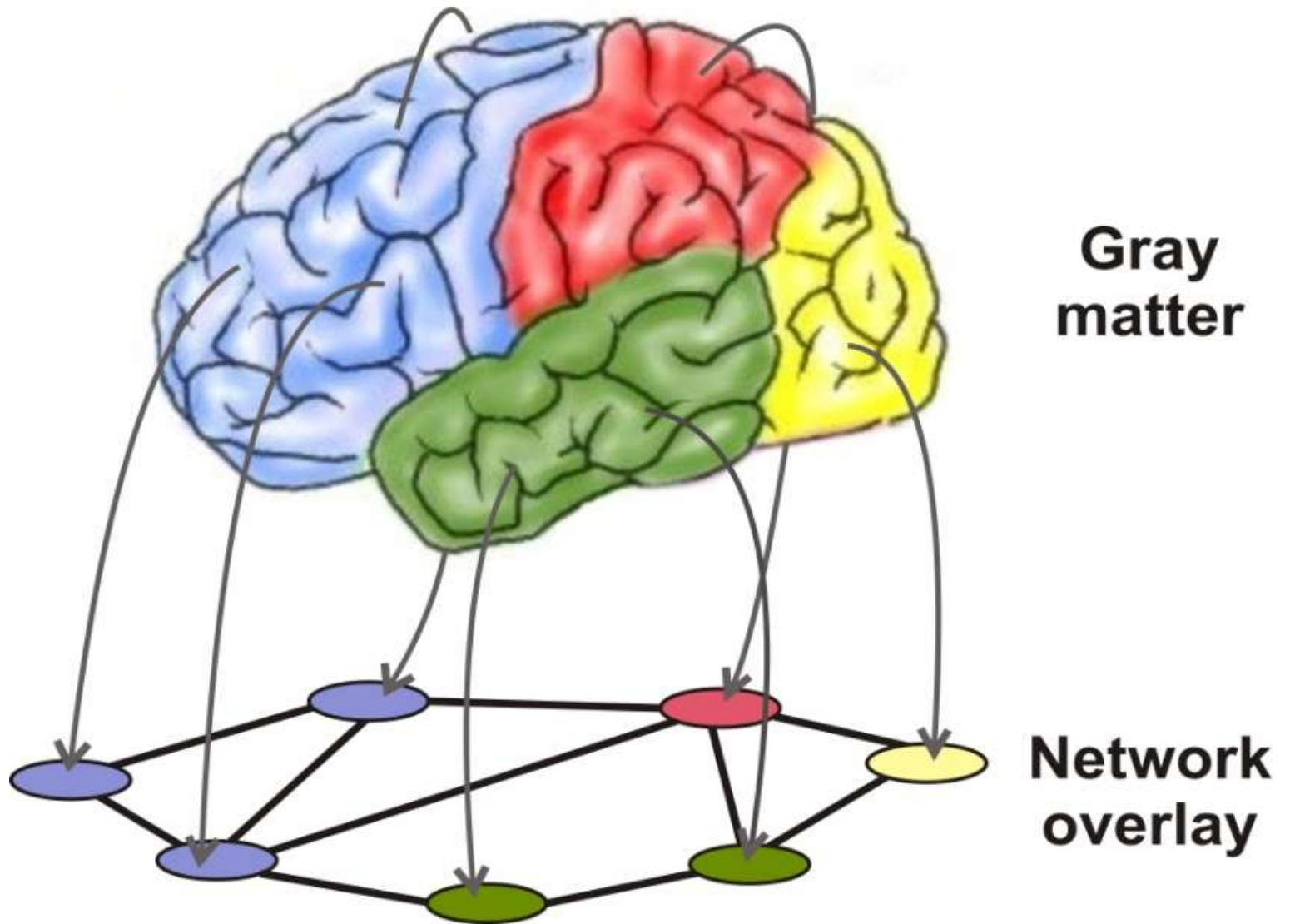
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Talk Outline

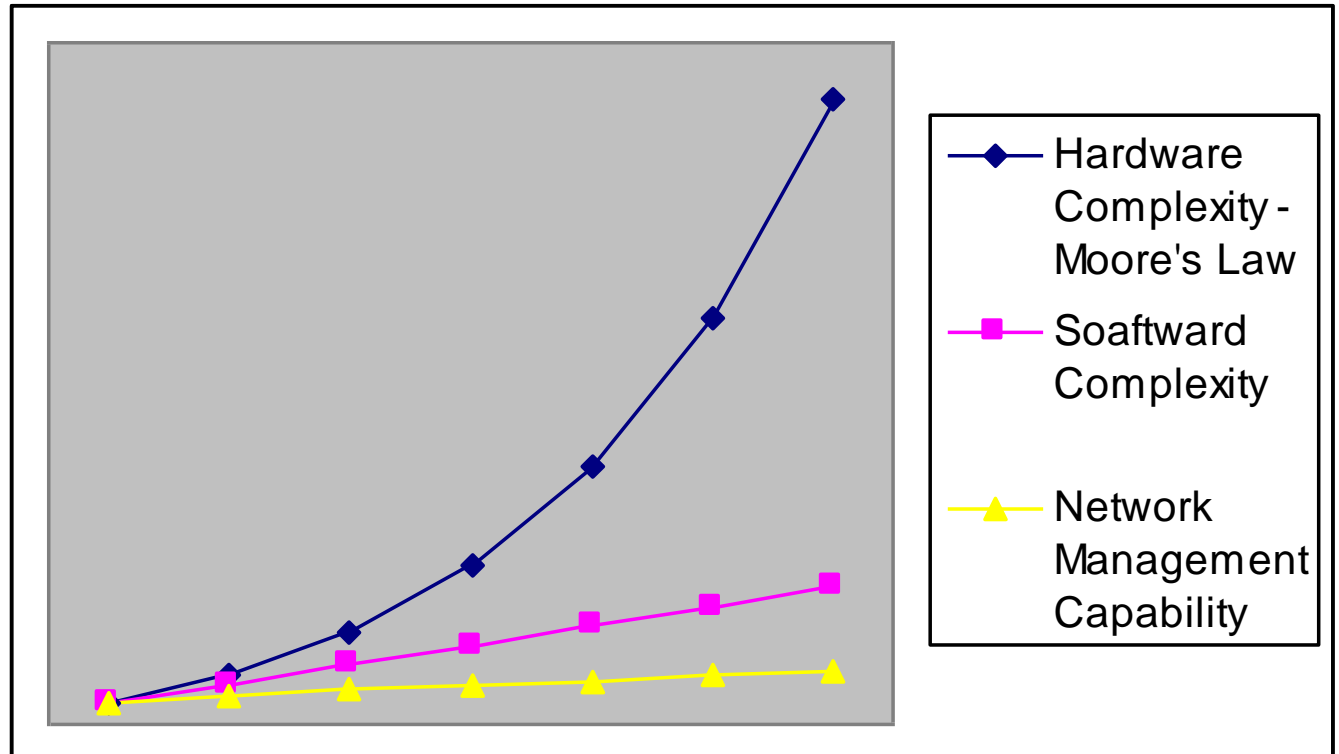
- Need for paradigm
- Inspiration from brain
- Gray Networking
- Conclusions
- Need for new paradigms
- Inspiration from the human brain
- Gray Networking
- Example
- Conclusions

The Need for New Paradigms

- Need for new paradigms
- Inspiration from brain
- Gray Networking
- Conclusions
- Moore's Law for computing power
- Similar law for storage
- +/- linear improvement in size of software manageable
- Sublinear increase in network management ability
- Increase in network complexity

The Need for New Paradigms

- Need for new paradigms
- Inspiration from brain
- Gray Networking
- Conclusions



Our ability to manage networks has not kept up with software, much less hardware complexity

=> Need new ways for network to self-manage

Inspiration from the Brain

- Need for paradigm
- Inspiration from brain
- Gray Networking
- Conclusions
- Recent advances in neural research using new technology
 - fMRI, PET, etc.
- Improved understanding of neural mechanisms
- Improved understanding of brain behaviors
 - Phantom limb, adaptation, etc.
- Still much to learn!

Below, you'll see a star on the left and a large dot on the right. Cover your left eye, and look at the star using your right eye. With your left eye closed, slowly move closer to your monitor. At some point, the dot on the right will vanish (if you move even closer, the dot will re-appear).



See <http://www.blindspottest.com>

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Maybe you're thinking that the light gray background is the key. Nope! Cover your left eye, and look at the dot again. When the star vanishes, your brain fills in the space with (you guessed it) blue.



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Flip the red and blue, and try again... Just as expected, the star vanishes, and your brain fills in the space with red.



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Ok, you get the picture (no pun intended!) For our finale, we're going to use a complex pattern instead of a solid color. Try it again. When the star vanishes, your brain will fill in the area that your eye can't see with the surrounding checkerboard pattern.

We don't know about you, but we're amazed!



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Inspiration from the Brain

- Need for paradigm
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- Gray Networking
- Conclusions
- Complementary redundancy
- Feed-forward and feed-back paths
- Probability-based analysis
- Compartmentalization
- Intelligent filtering/fusion
- Multi-level feedback
- Entropy-based attention focus

Gray Networking Characteristics

- Need for paradigm
- Inspiration from brain
- Gray Networking
- Conclusions
- Functional Compartmentalization
- Inter-component adaptable filters
- Separate learning module/logic
- Criteria-based graduation of information in memory hierarchy
- Multiple sensor monitoring
- Smart interpolation/extrapolation
- Ample redundancy & recovery

Potential Benefits

- Need for paradigm
- Inspiration from brain
- Gray Networking
- Conclusions
- Reduce management burden
- Improve context awareness
- Improve situation awareness
- React quicker
- Heal more seamlessly

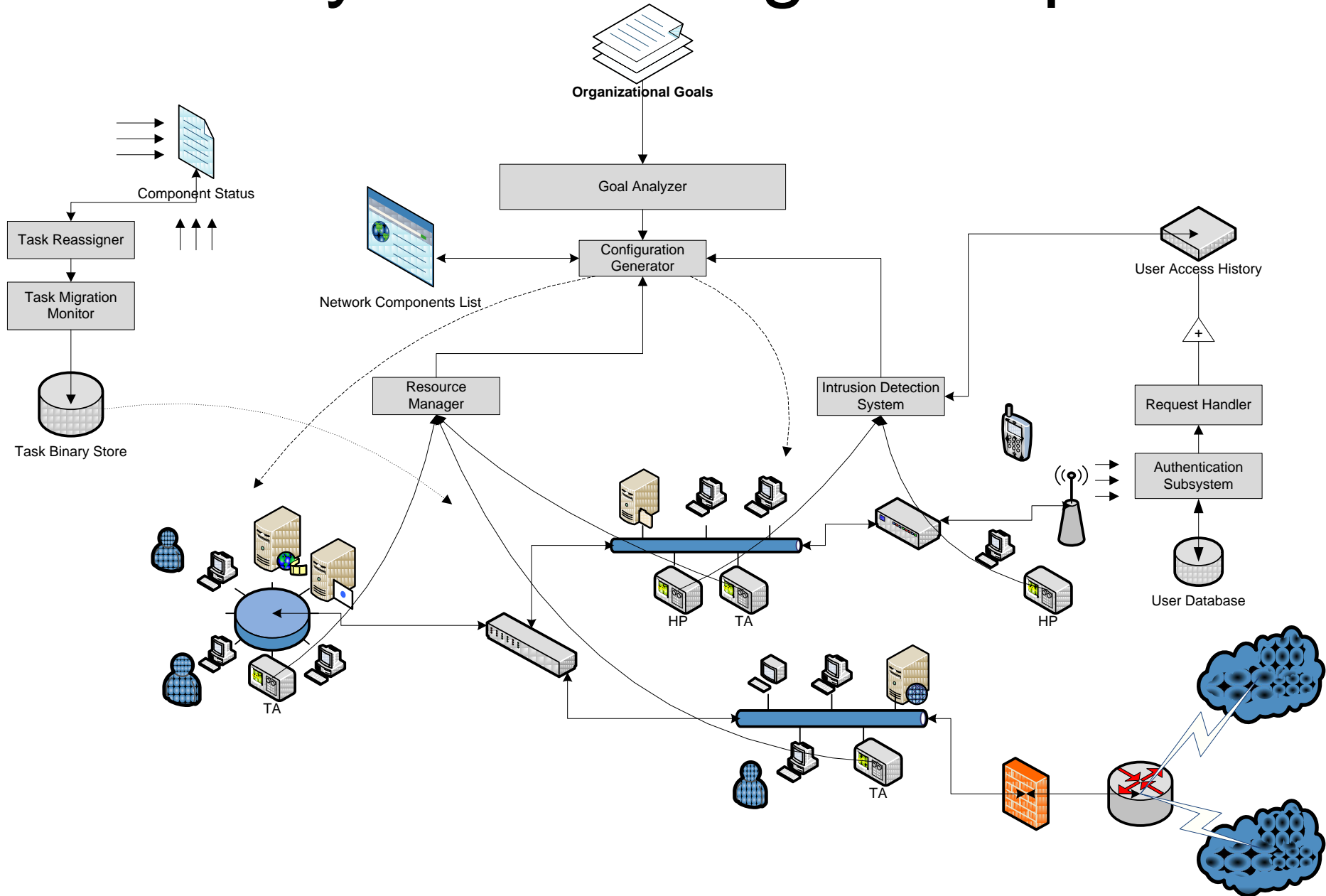
Potential Drawbacks

- Need for paradigm
- Inspiration from brain
- Gray Networking
- Conclusions
- Brain structure still not well understood
- Automatic decisions may be wrong
- Partial compromise may lead to total compromise

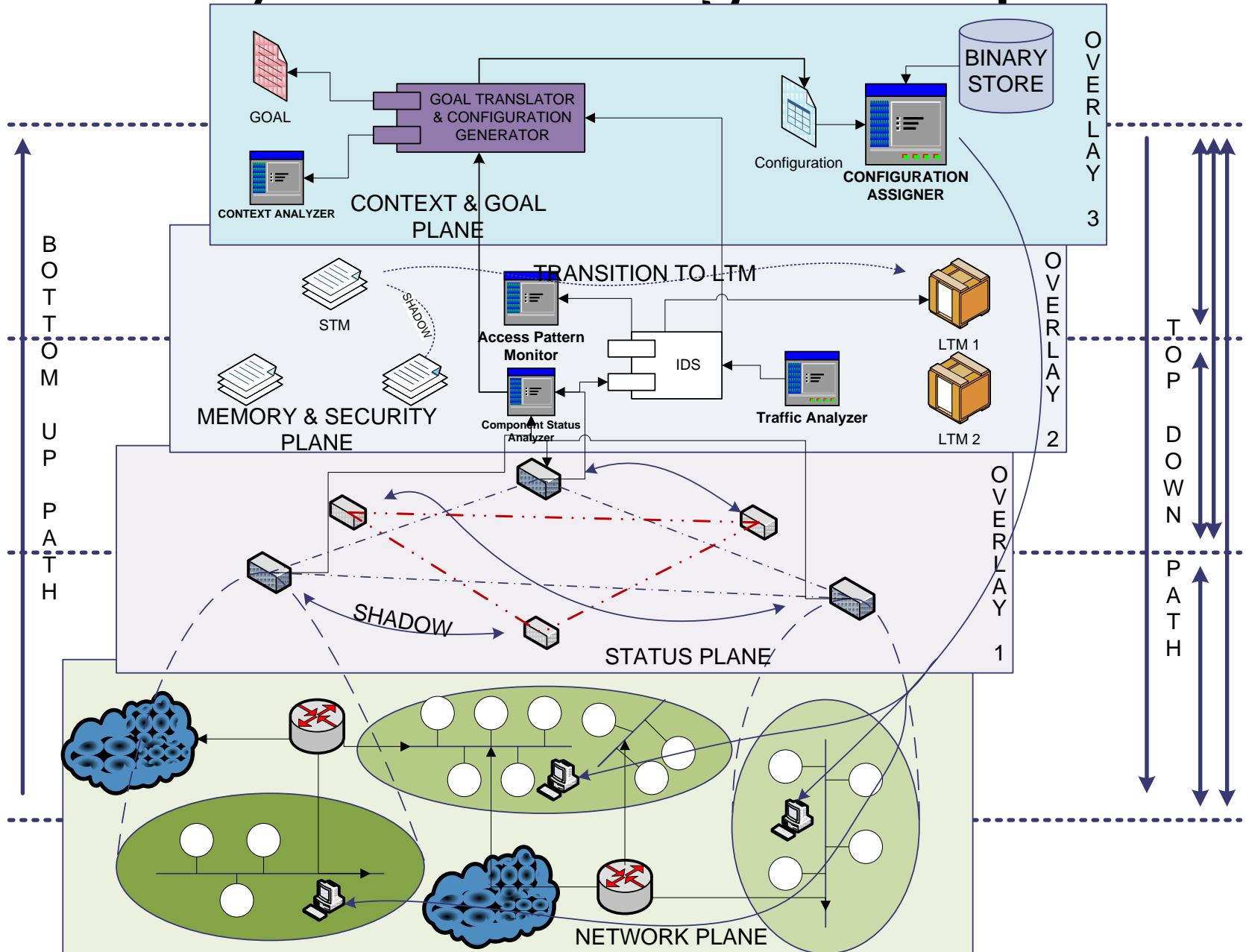
Gray Networking Example

- Need for paradigm
- Inspiration from brain
- Gray Networking Example
- Conclusions
- Example of Gray Networking Model shows mapping in concrete context
- Not exhaustive
- Demonstrate application of model to design

Gray Networking Example



Gray Networking Example



Gray Networking Example

- Need for paradigm
- Inspiration from brain
- Gray Networking Example
- Conclusions
- Functional Compartmentalization
 - System decomposition
- Inter-component adaptable filters
- Separate learning module/logic
- Criteria-based graduation of information in memory hierarchy
 - Memory & security plane

Gray Networking Example

- Need for paradigm
- Inspiration from brain
- Gray Networking Example
- Conclusions
- Multiple sensor monitoring
 - IDS, Resource monitor
- Smart interpolation/extrapolation
 - Status plane
- Ample redundancy & recovery
 - Context & goal plane, configuration assigner

Conclusions

- Need for paradigm
- Inspiration from brain
- Gray Networking
- **Conclusions**
- Biologically-inspired computing can yield benefits
- The human brain provides some exemplary capabilities
- Gray Networking takes a step in the direction of applying human brain paradigms to networking
- Work has just begun