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## Cross-Layer Design for Multi-Media Applications on Mobile Phones



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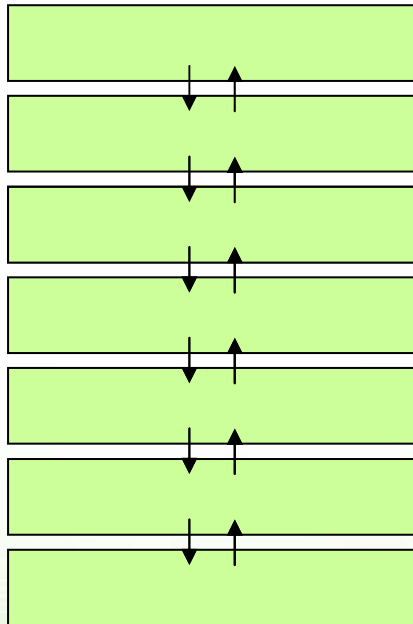
## What is cross-layer design?

- » Traditional layered protocol stack architecture
  - Layers only allowed to communicate with adjacent layers
  - Specific interfaces for comm. between layers
- » Cross-layer design
  - Extends the architecture by alteration of interfaces compared to the reference architecture
  - Extends the architecture by communicating with non-adjacent layers
- » From a layered architecture point-of-view, cross-layer means enabling new interactions between non-adjacent layers and exchanging information and control between layers that was not possible in the original architecture

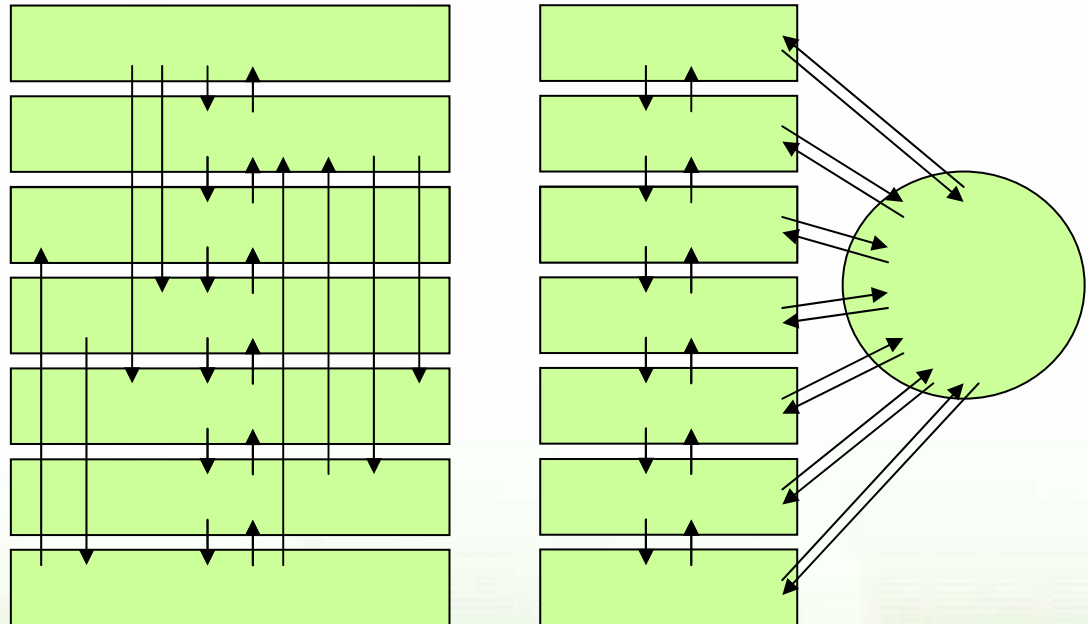
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## Cross-layer concept

Traditional



Cross-layer



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## What is cross-layer design?

- » A "non-destructive" approach
  - Layered architecture fundamentally a good idea
  - Layered architecture should be kept intact – it still provides us with for example the flexibility of being able to adapt the protocol stack to different radio technologies by exchanging some of the lower layers or to use any application at the highest layers
  - Cross-layer design used for enhancing the existing architecture by exploiting opportunities in the flexibility of the protocol layers

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## A need for caution

- » Cross-layer design enables performance gains in a multitude of different aspects of wireless networking
- » Also potentially goes against some important benefits of the original layered architecture
  - Modularity
    - A given cross-layer implementation may inter-weave two or more layers so dependently that these layers cannot be separated
  - Flexibility
    - A given implementation may introduce dependencies in the protocol stack meaning that one layer's protocol cannot simply be replaced by another one

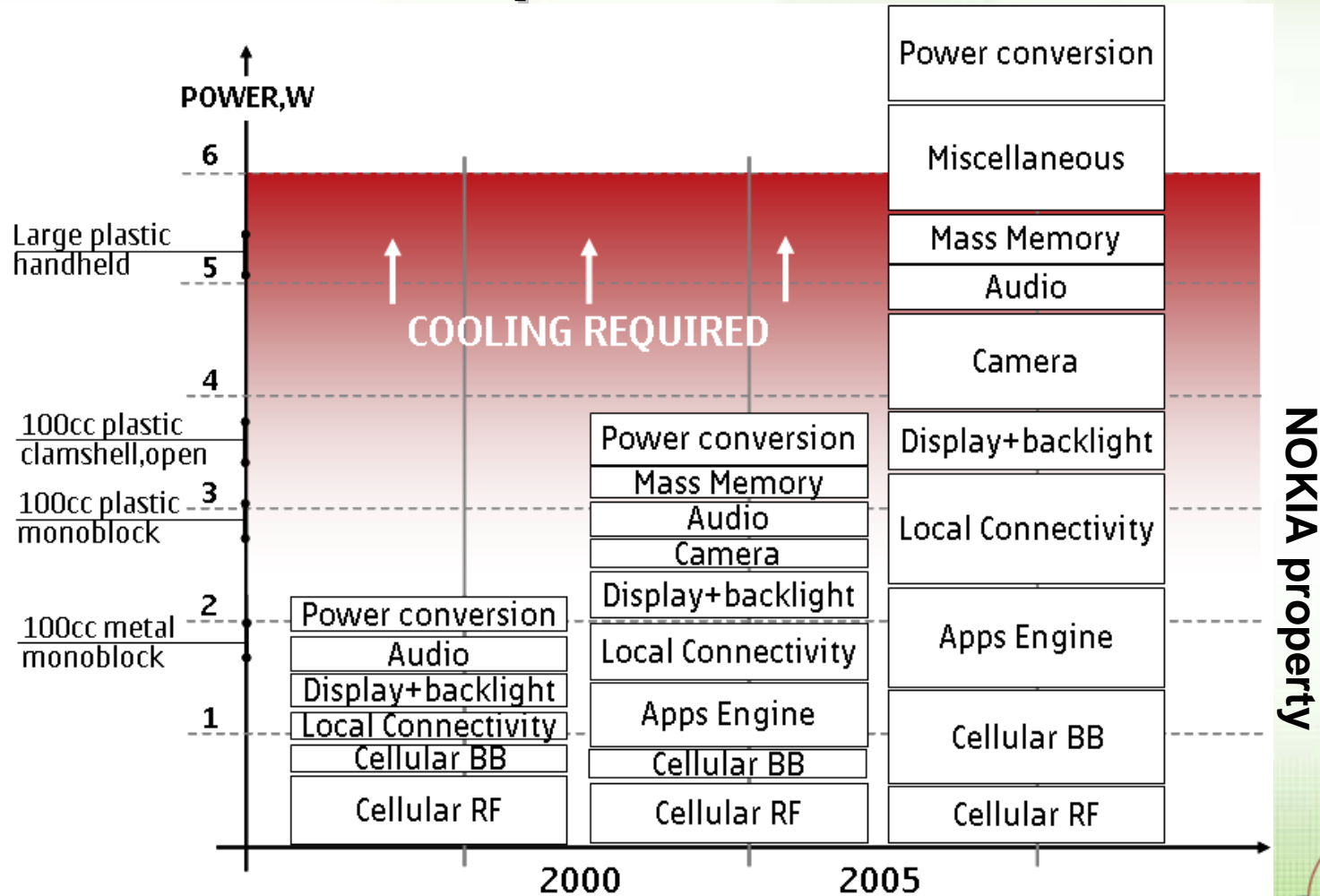
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## A need for caution

- » In any design implemented one should consider its possible impact on the existing protocol stack
  - This is pointed out by Kawadia & Kumar (2003) in a somewhat pessimistic way
- » Some cross-layer optimizations may drastically increase computational complexity
  - Due to the additional degrees of freedom that are involved in optimizing the protocol stack's performance

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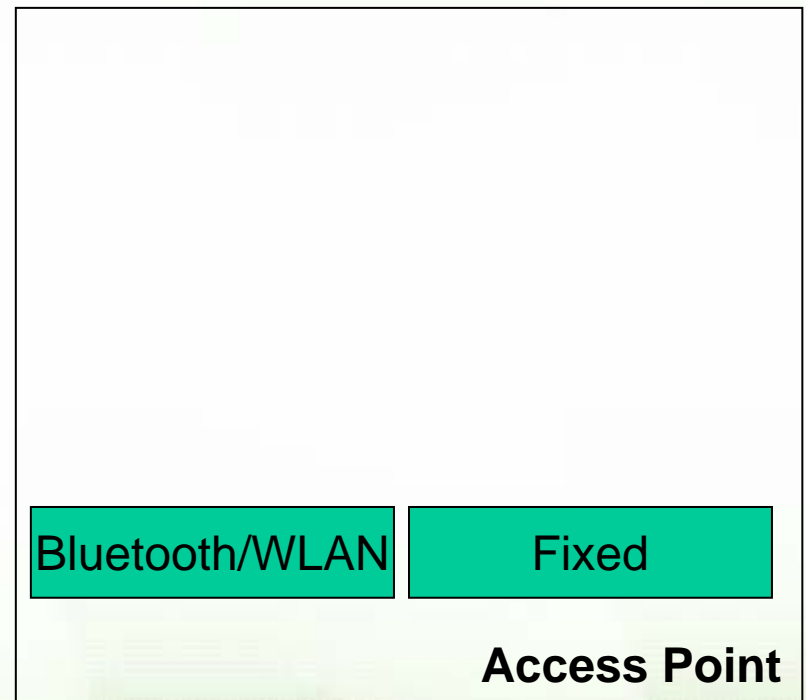
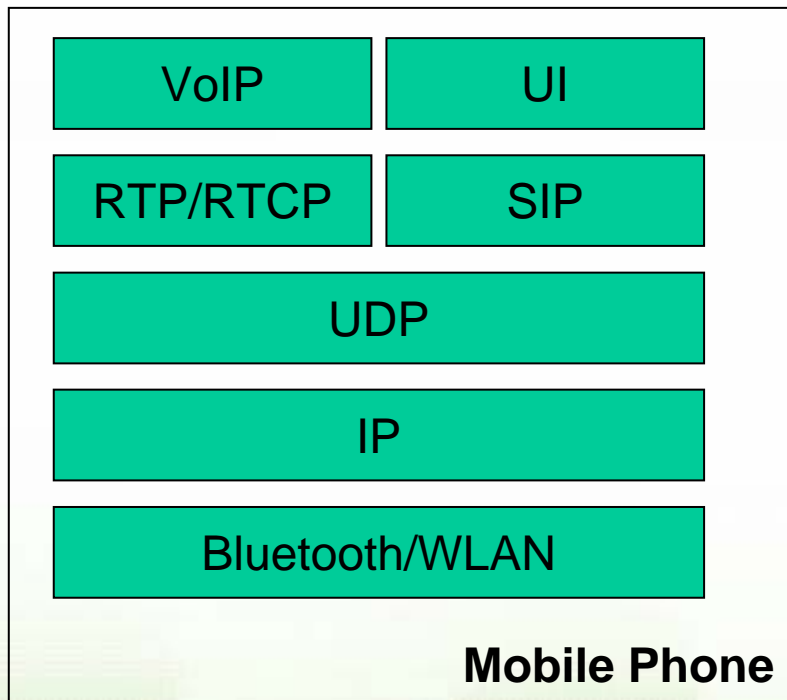
## Power Consumption: State of the Art



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## Cognitive Mobile Phone

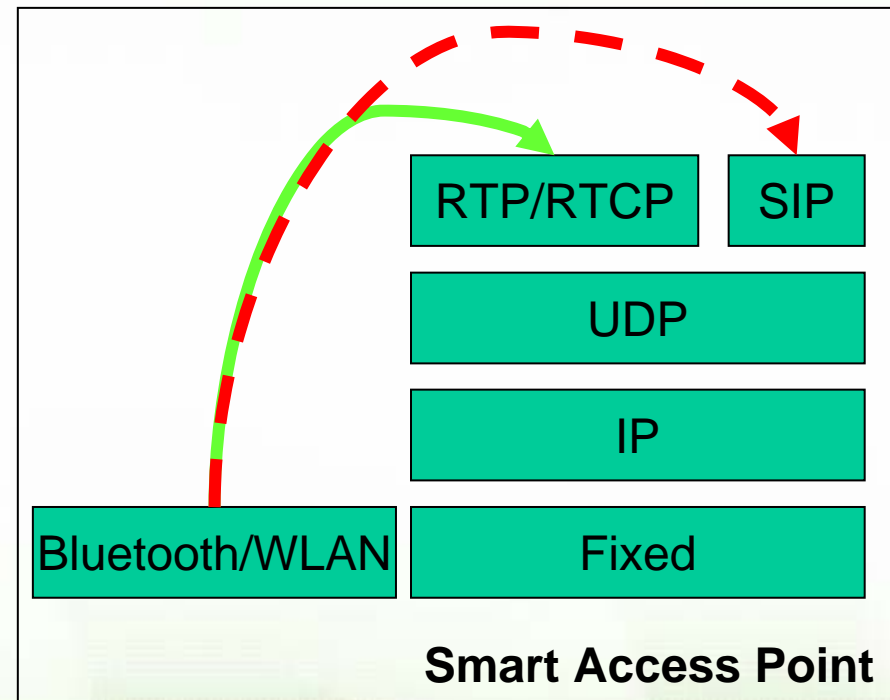
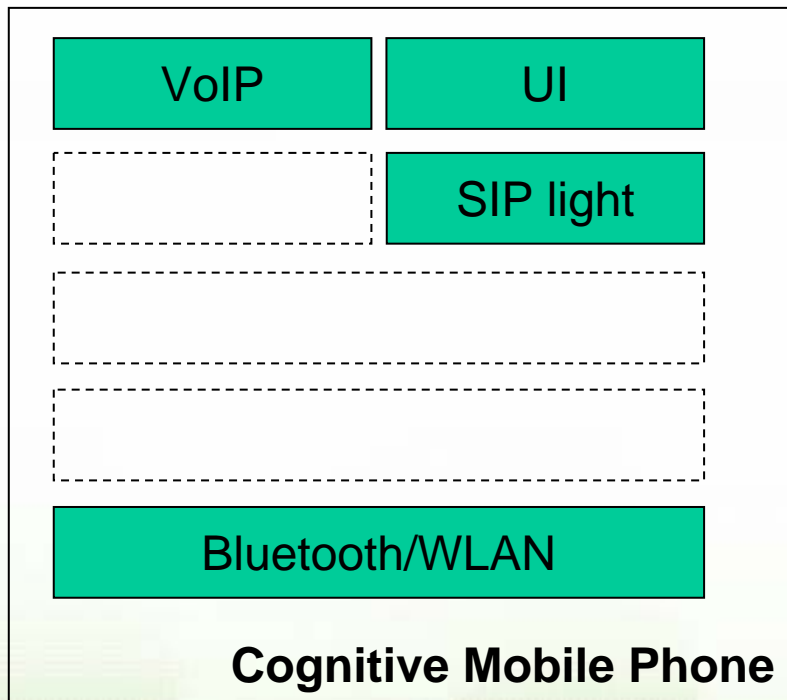
» VoIP over WLAN (UMA, etc)



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## Cognitive Mobile Phone

» VoIP over WLAN (UMA, etc)



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## Performance / Complexity

