Autonomous Computing

Fiefdoms and Emissaries

Outline

- Introduction
- Autonomous Computing: The Basics
- Working With Autonomous Fiefdoms
- Working Across Fiefdoms
- Conclusion

Legal Stuff

The following page has definitions excerpted from Bookshelf 99

ex·cerpt ex·cerpt (ĕk'sûrpt´) *noun*
A passage or segment taken from a longer work, such as a literary or musical composition, a document, or a film.

Terminology

Autonomous	Not controlled by others or by outside forces; independent
Fiefdom	1. The estate or domain of a feudal lord. 2. Something over which one dominant person or group exercises control
Emissary	An agent sent on a mission to represent or advance the interests of another.
Snapshot	A photograph take with a small hand-held camera.
Stable	Resistant to change of position or condition; steadfast. Immutable; permanent; enduring. A place where horses live.
Uncertainty	Unsure about someone or something. A lack of assurance or conviction.
Idem	Something that has been mentioned previously; the same.
Potent	Possessing inner or physical strength; powerful.

What Is Autonomous Computing?

- **Autonomous Computing starts with independent computer systems**
  - These are independently controlled and managed
  - They don't trust outsiders
- **We are going to examine the consequences of this independence**
  - How do such machines interact?
  - How is data handled?
  - How can we accomplish work in such an environment?

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  - Rethinking the "N-Tier" Model
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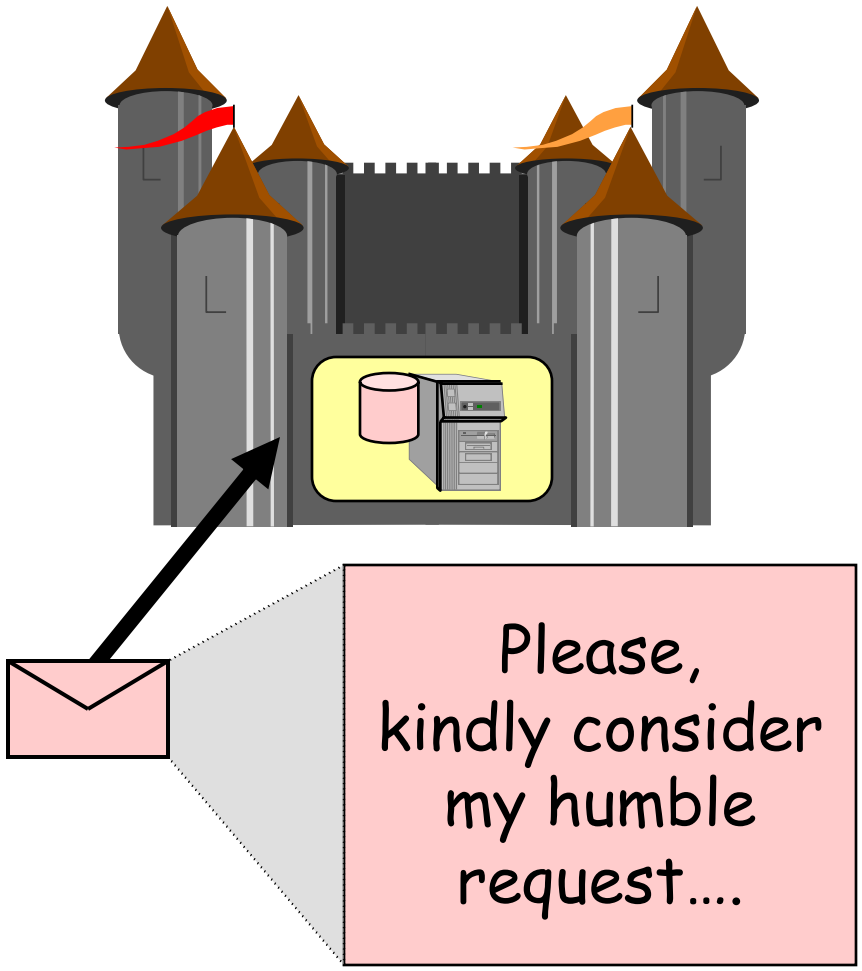
The Web is Autonomous Computing

- The Web is lots of autonomous fiefdoms
- Define the term Fiefdom as:
  - Computing function and applications which behaves as an independent entity
  - Has private data
  - An autonomous unit --- managed independently
    - Usually one (or a few) machines
- Fiefdoms don't trust outsiders...

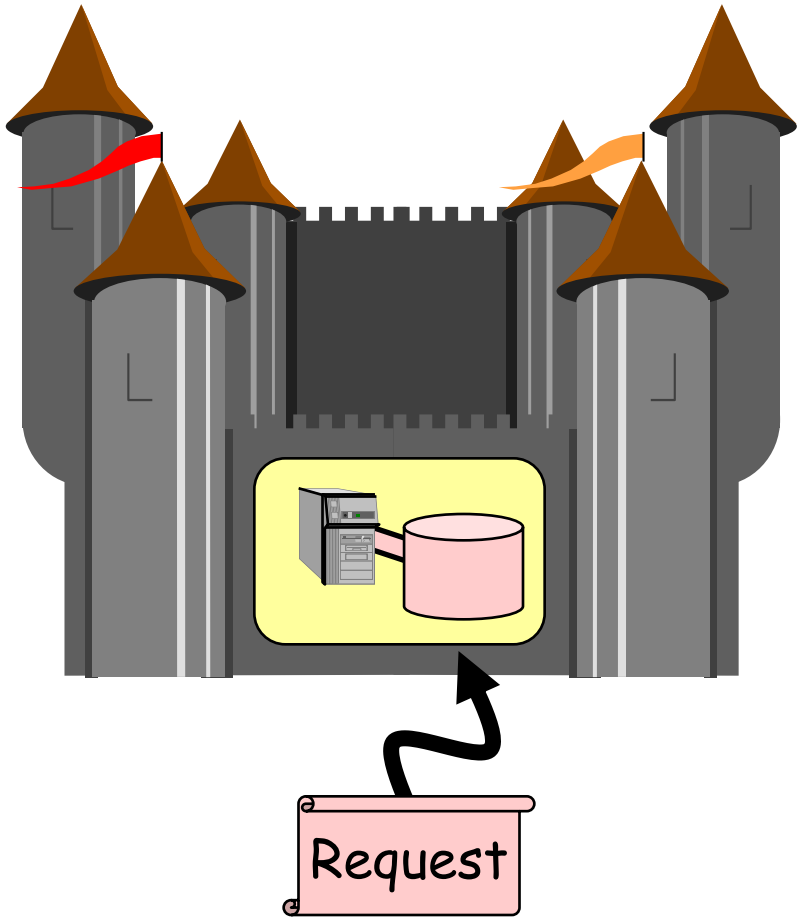
Requesting Service from a Fiefdom

- **Fiefdoms don't trust stuff from the outside**
  - Incoming requests will be inspected
  - Fields will be validated
  - Identity will be authenticated
- **Data from outside requests is never trusted**
  - It must fit within prescribed values or it is rejected



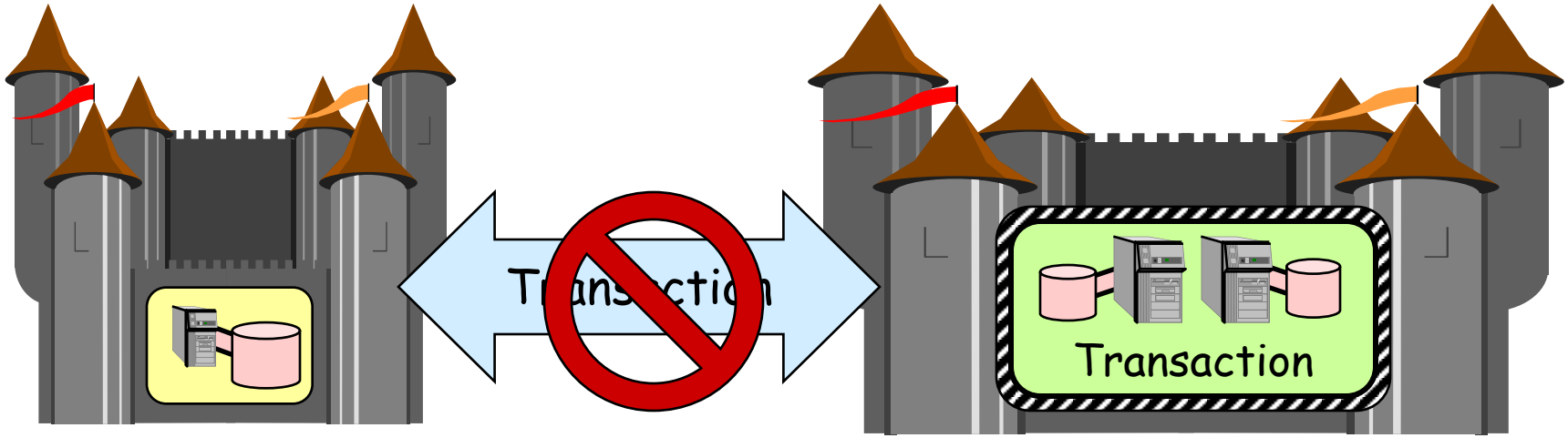
Private Data and Fiefdoms

- **A fiefdom keeps its data private**
  - No one outside can read or write the data
  - Only well defined requests are serviced from the outside
    - These requests do not describe the contents of the fiefdom's data
    - Provide services, not data access



Transactions and Fiefdoms

- Fiefdoms are built using transactions internally
  - It may use 2-phase commit across the nodes of a cluster
- A fiefdom (usually) will not agree to share a transaction with an outsider



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Emissaries

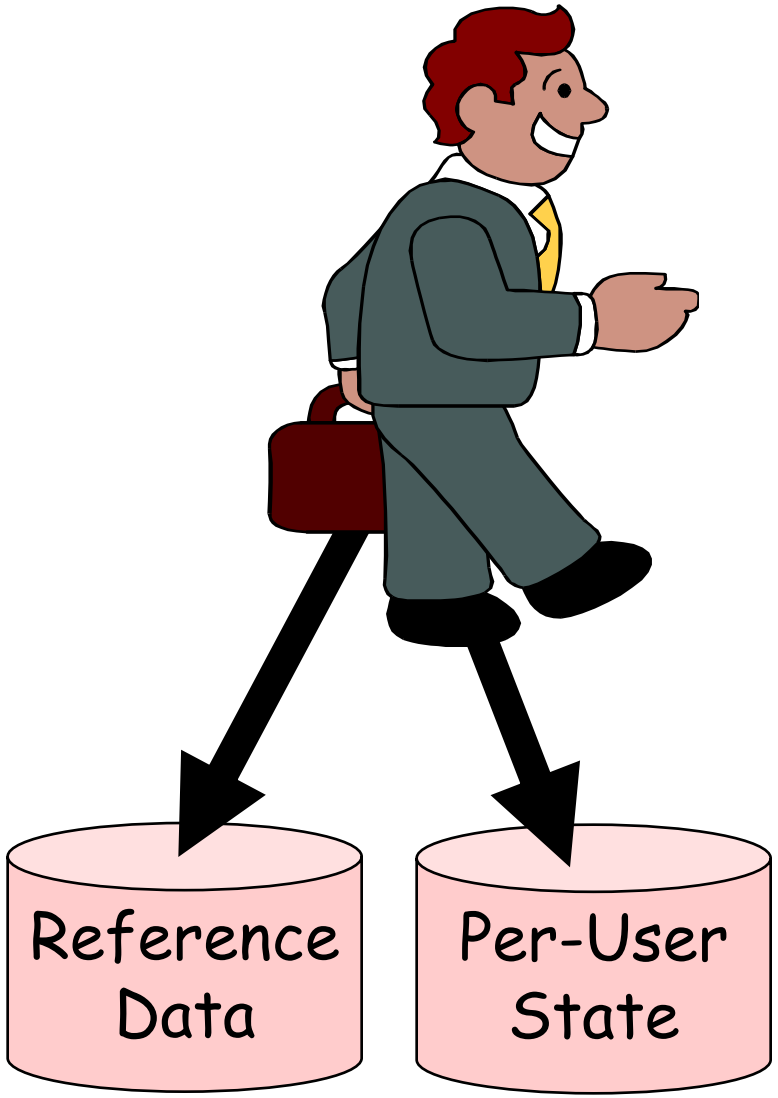
- **Fiefdoms may come with emissaries.**
  - It knows how to fill out a request for the fiefdom
  - It understands the rules of the fiefdom and how to (probably) get the request accepted
    - Think of a mortgage broker… not the final approving party…
- **Emissaries have two purposes:**
  - Displaying information to users
  - Preparing requests to send to fiefdoms
- **Emissaries are not trusted by the fiefdom**
  - The contents of the request is still inspected for correctness

Emissaries & Snapshot Reference Data

- **An emissary will frequently come with reference data.**
  - This information will support the emissary in doing its job
- **Imagine an emissary that helps you order from Sears**
  - It will arrive with the Fall catalog under its arm

Emissaries & Single User Data

- **Emissaries gather information needed to prepare requests**
  - For example, a shopping basket accumulates the items to purchase



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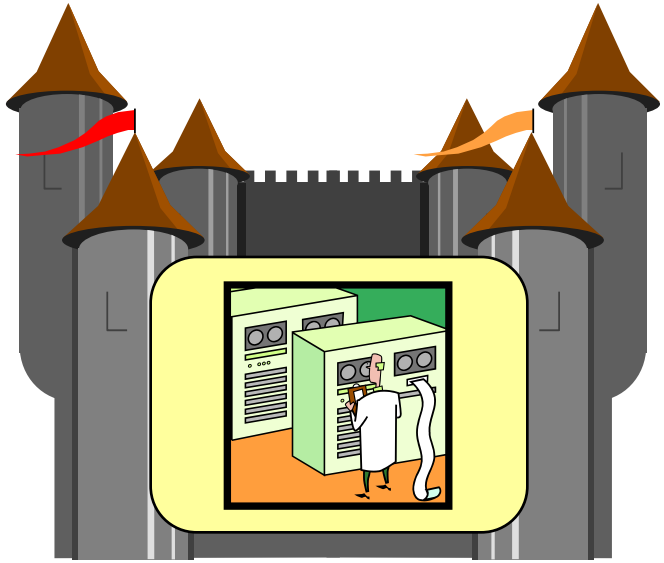
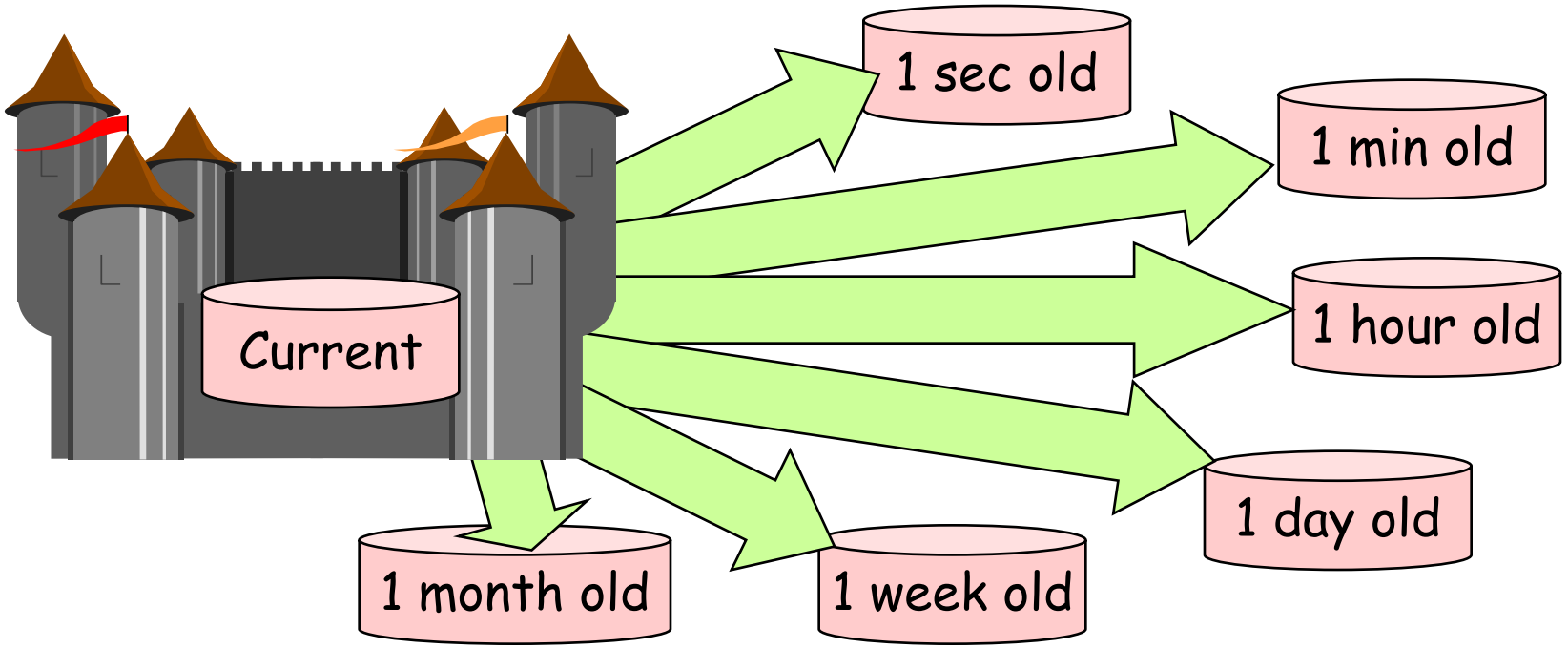
Mission Critical Data

- **The "current" data is always kept inside the fiefdom**
  - It is the mission critical data that describes the business of the fiefdom
  - This information is typically updated within a transaction
  - Locks are held only for the duration of the transaction
  - Transactions are not shared outside the fiefdom



Snapshot Data

- **Once data is unlocked, it must be assumed to be a snapshot**
  - Snapshot data was accurate and up-to-date at some time in the past… it is not necessarily still current
  - We must assume that snapshot data is no longer current…

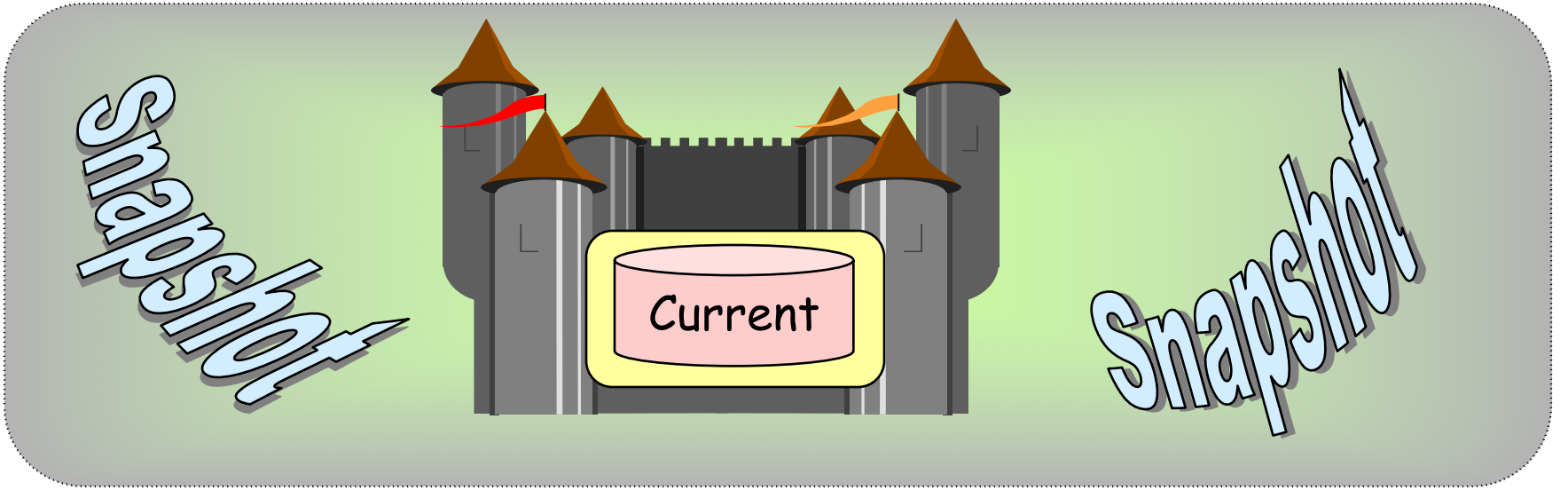


Stable Data & Immutable Data

- **Stable data is meaningful across space and time**
  - Anything to do with "current" is not stable
  - Timestamping can make data stable
  - Other techniques can make data stable
    - Given an IID (Interface-ID), type-lib info is stable
- **Immutable data is a snapshot that never changes**
  - It is never invalid
  - It may be cached without worries for cache consistency
  - It may be uninteresting, but it is never wrong…

All Web Data Is a Snapshot

- **All web data is a snapshot**
  - Fiefdoms don't hold locks when working with outsiders…
  - This means they have unlocked their data… it might have changed…



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Labeling the Tiers

Rendering

May accept HTML or some other rendering format
Produces bits on the screen.

Present-ation

Maps the interactions with the emissary into pages to be displayed to the user. Typically produces HTML.

Emissary Logic

Emissary Data

Knows how to fill out requests to be submitted to the fiefdom. Possibly has snapshot data for submitting requests.

Fiefdom Logic

Fiefdom Data

Business logic implementing the fiefdom. Doesn't trust anyone. Takes requests into the fiefdom. Keeps mission critical data.

Slicing at the Front

Rendering

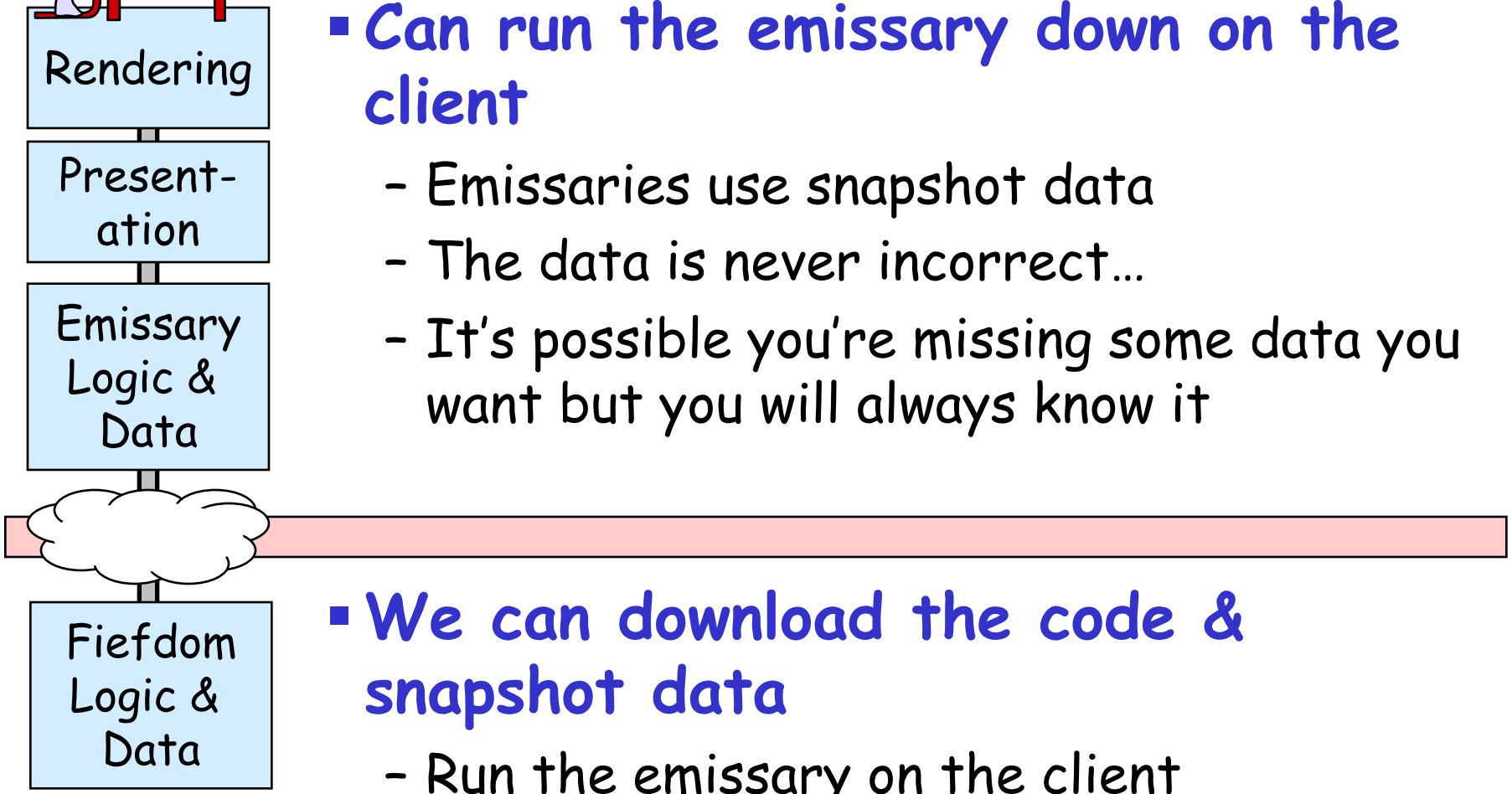
Present-ation

Emissary Logic & Data

Fiefdom Logic & Data

- **This is classic HTML 3.2 browser support**
  - Do most of the work at the server
  - Send HTML to the client
  - Maximum "reach"

Pushing Down the Emissary



- **Can run the emissary down on the client**
  - Emissaries use snapshot data
  - The data is never incorrect…
  - It's possible you're missing some data you want but you will always know it
- **We can download the code & snapshot data**
  - Run the emissary on the client
  - Send the fiefdom requests over the wire

The Web Farm

Rendering

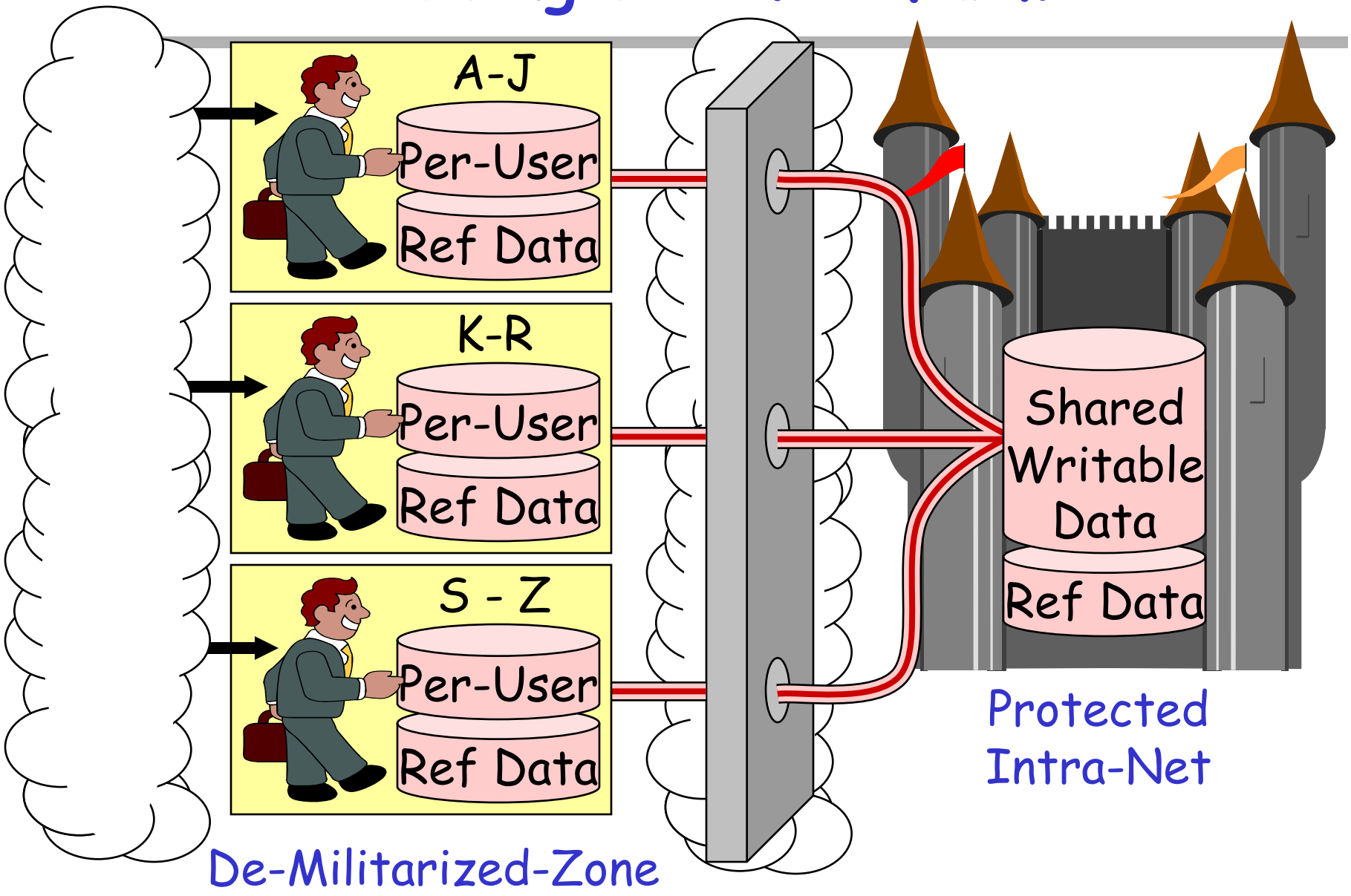
Present-ation

Emissary Logic & Data

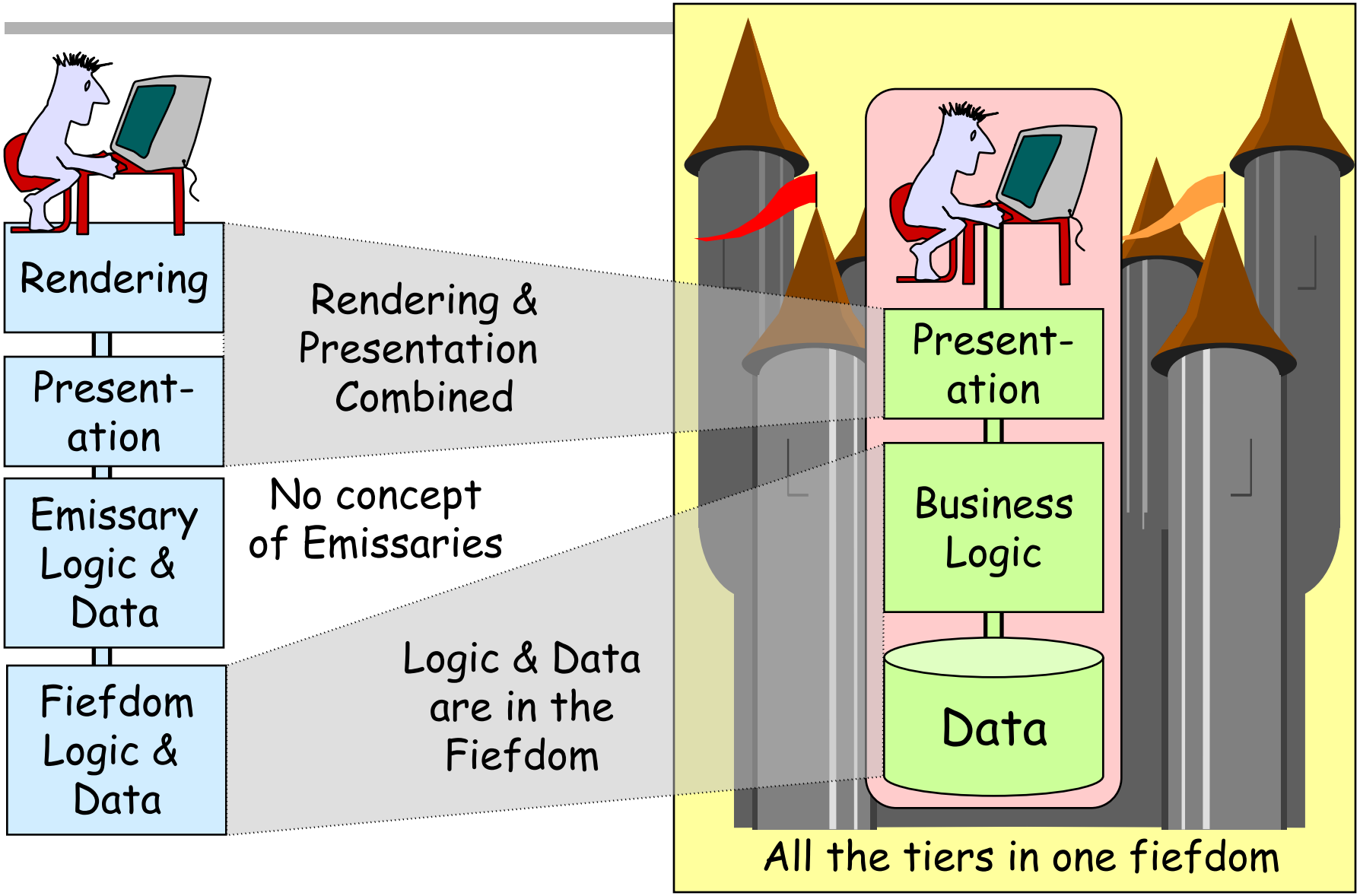
Fiefdom Logic & Data

- **Can run the emissary separate from the fiefdom**
  - Talks over HTML 3.2 to the browser
  - Talks to a dedicated machine with fiefdom logic and data
- **Scalable solution**
  - Offloads the precious fiefdom
  - Emissary can be replicated on webfarm for scale

Scaling the Web farm



Contrast With Classic Tiers



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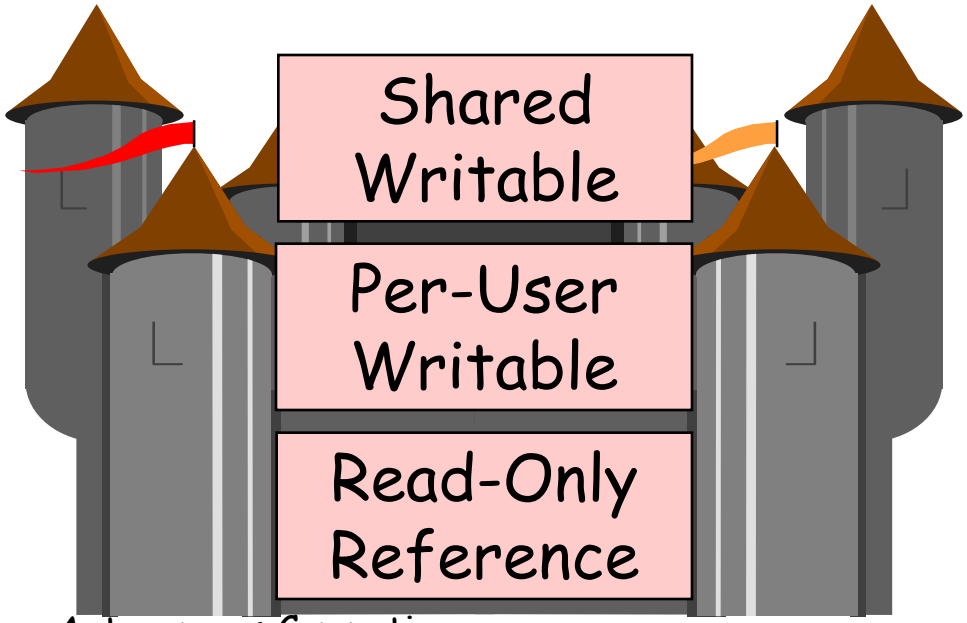
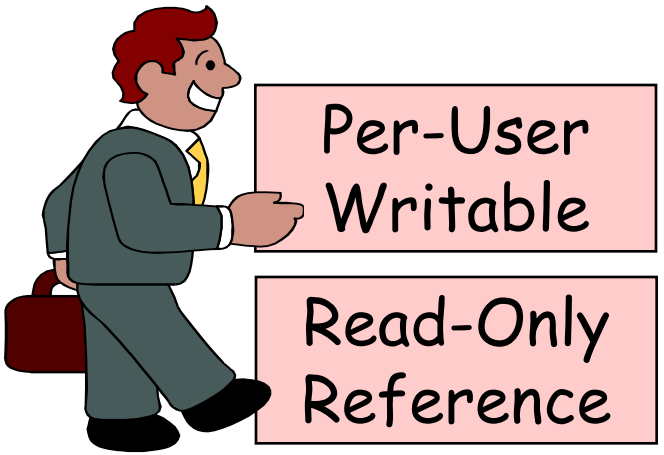
Fiefdoms & Emissaries

- **Fiefdoms use multi-user writable data**
  - The business logic protects its integrity
- **Emissaries use:**
  - Read-only reference data, and
  - Single-user writable data (e.g. a shopping basket)





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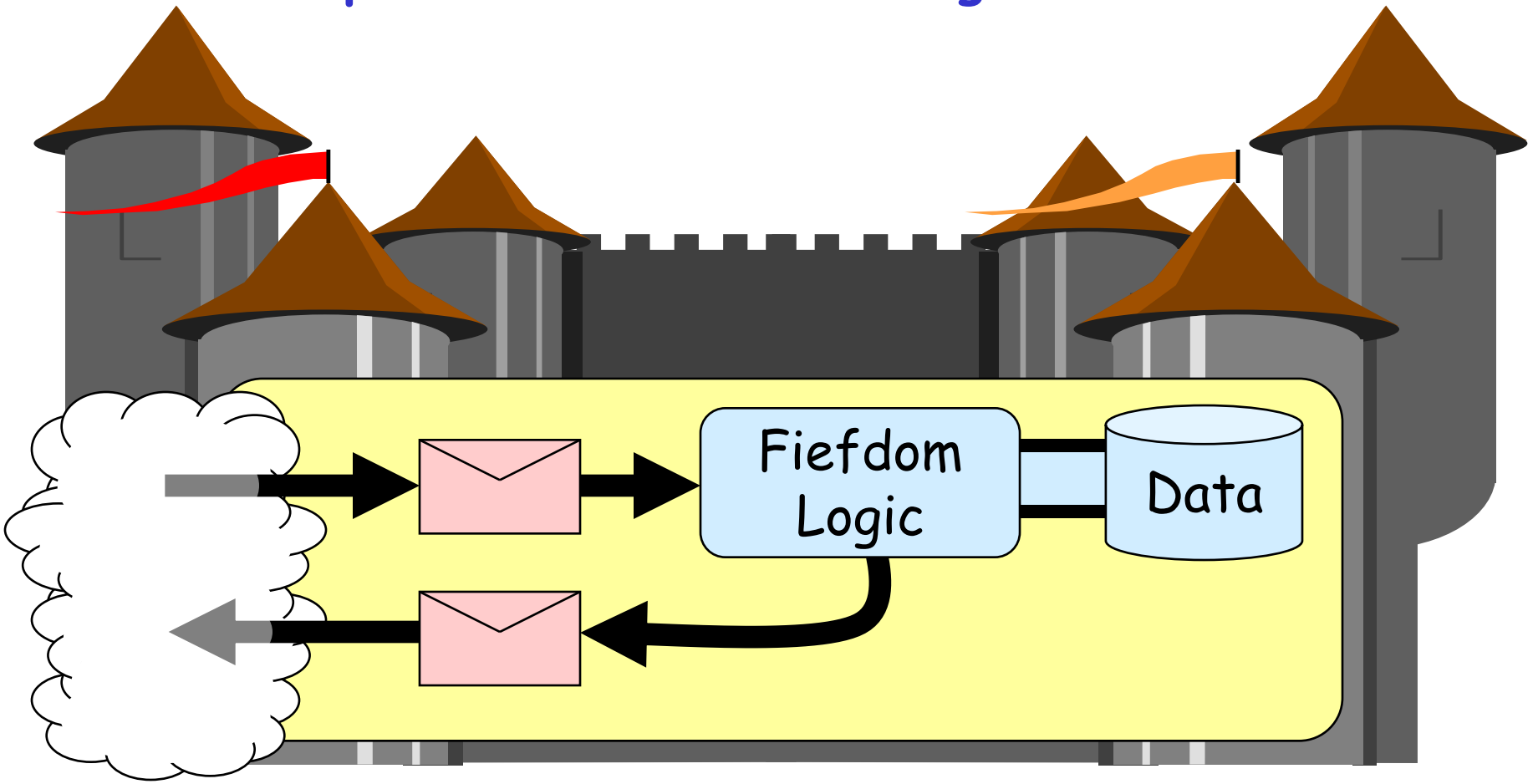
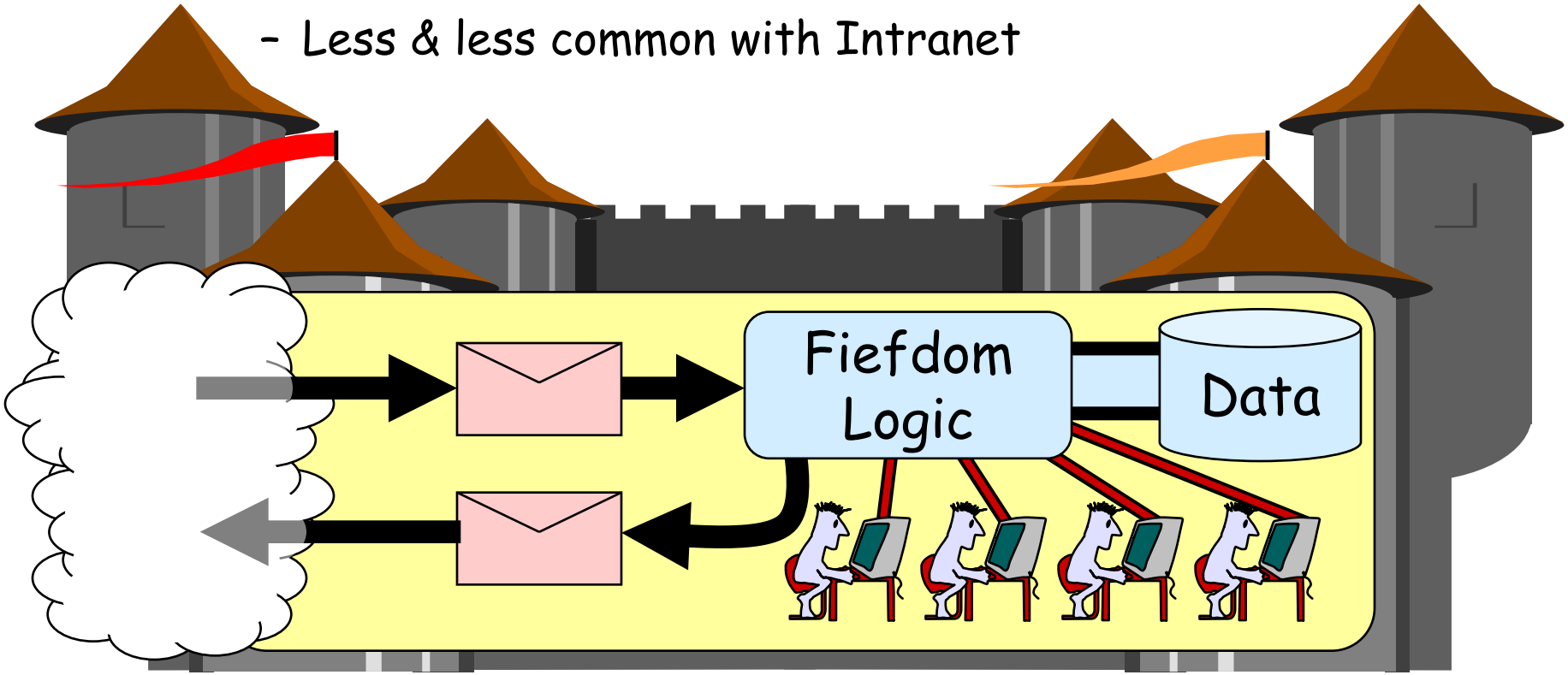
Computing With Messages

- Incoming work arrives in a message
- The response leaves in a message



Classic OLTP & 3-Tier

- **Sometimes online workers are part of the fiefdom**
  - They are trusted and work using online transactions
  - This is classic OLTP and 3-tier
  - Less & less common with Intranet



Making Requests Idempotent

- **Requests get lost…**
  - Gotta retry them to handle lost requests
- **Requests arrive more than once…**
  - Those pesky retries may actually arrive
- **Idempotent means it's OK to arrive multiple times**
  - As long as the request is processed at least once, the correct behavior occurs
- **In today's internet, you must design your requests to be idempotent**

Challenges With Idempotent Requests

- **Any request may arrive multiple times**
  - Sometimes after quite a while
  - You might be a few messages farther along when an old one arrives
- **The combinatoric complexity can be staggering**
  - This leads people to build very simple applications since only then can they cope with the failure complexity…

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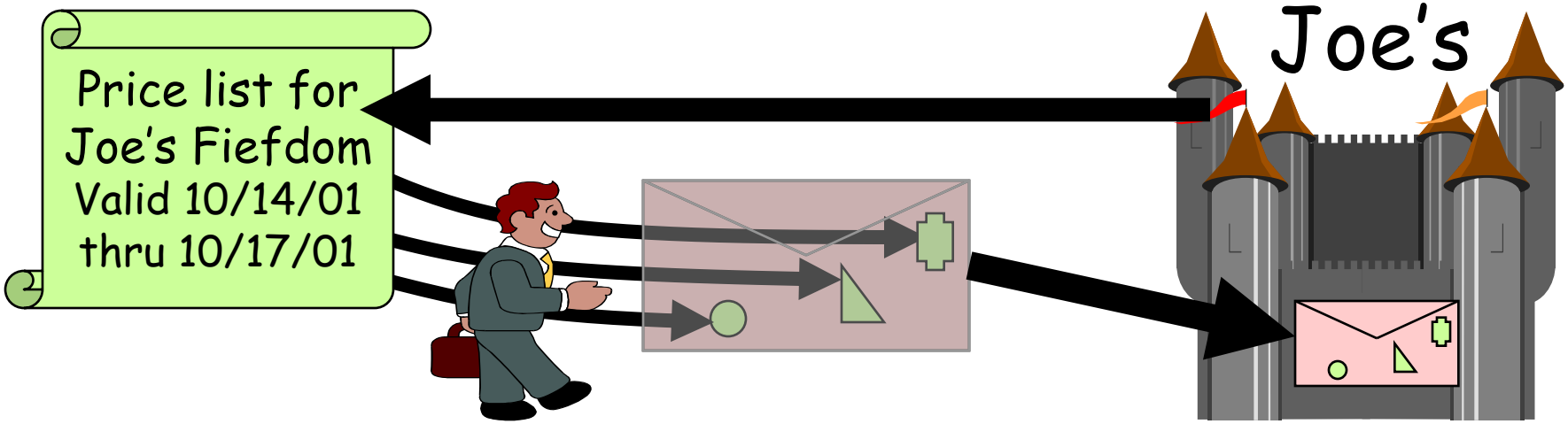
Content Syndication

- To fill out requests, an emissary needs snapshot reference data
  - The fiefdom must publish this reference data
- Content Syndication is the buzzword for the publication of reference data

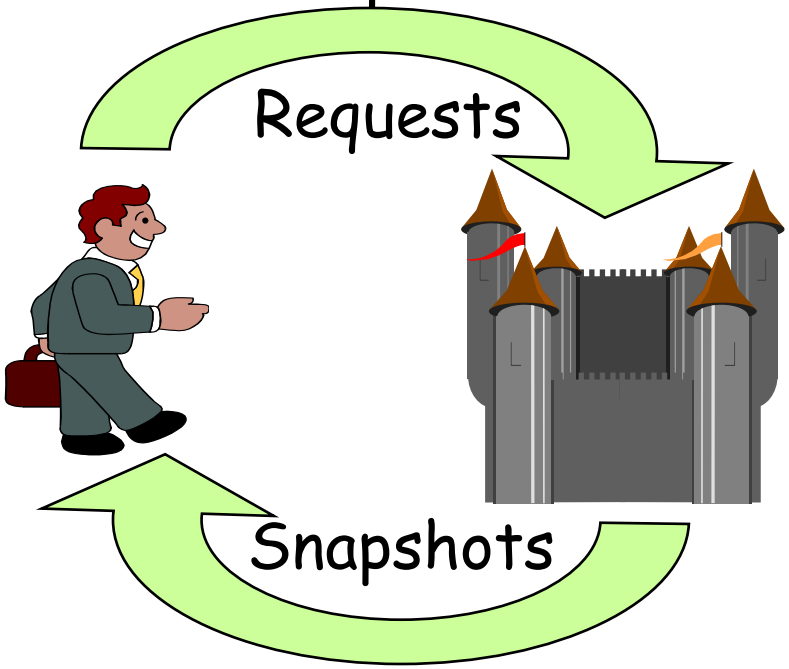
Using Syndicated Content In Requests for Service

- Emissaries use syndicated content to prepare requests for service
  - The processing of the request must be designed to tolerate some staleness



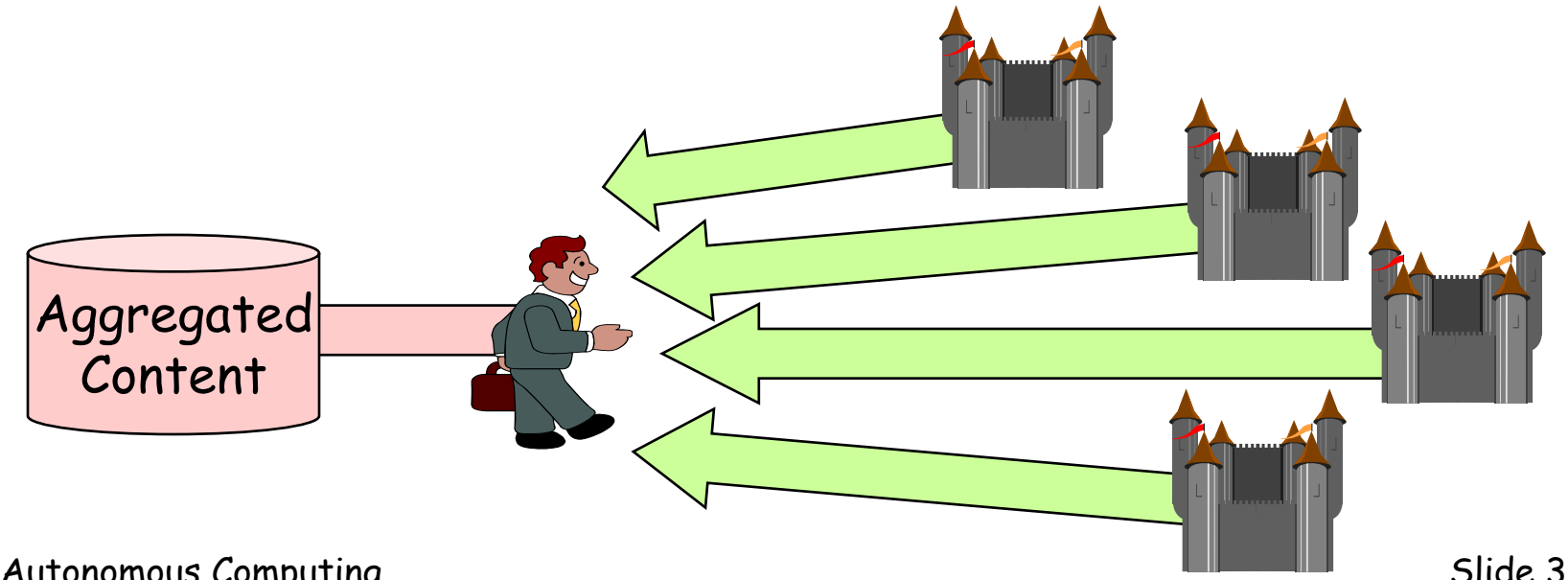
The Flow of Data

- **Data flows in a big cycle:**
  - The fiefdom published reference data
  - This reference data is used in requests for service
  - The processing of requests may impact the new reference data that is published later



Content Aggregation

- **Another buzzword is Content Aggregation**
  - You process syndicated content from multiple sources to glean interesting data
  - For example, which supplier has the best price, quality, and availability
- **Some emissaries perform sophisticated processing to aggregate content**



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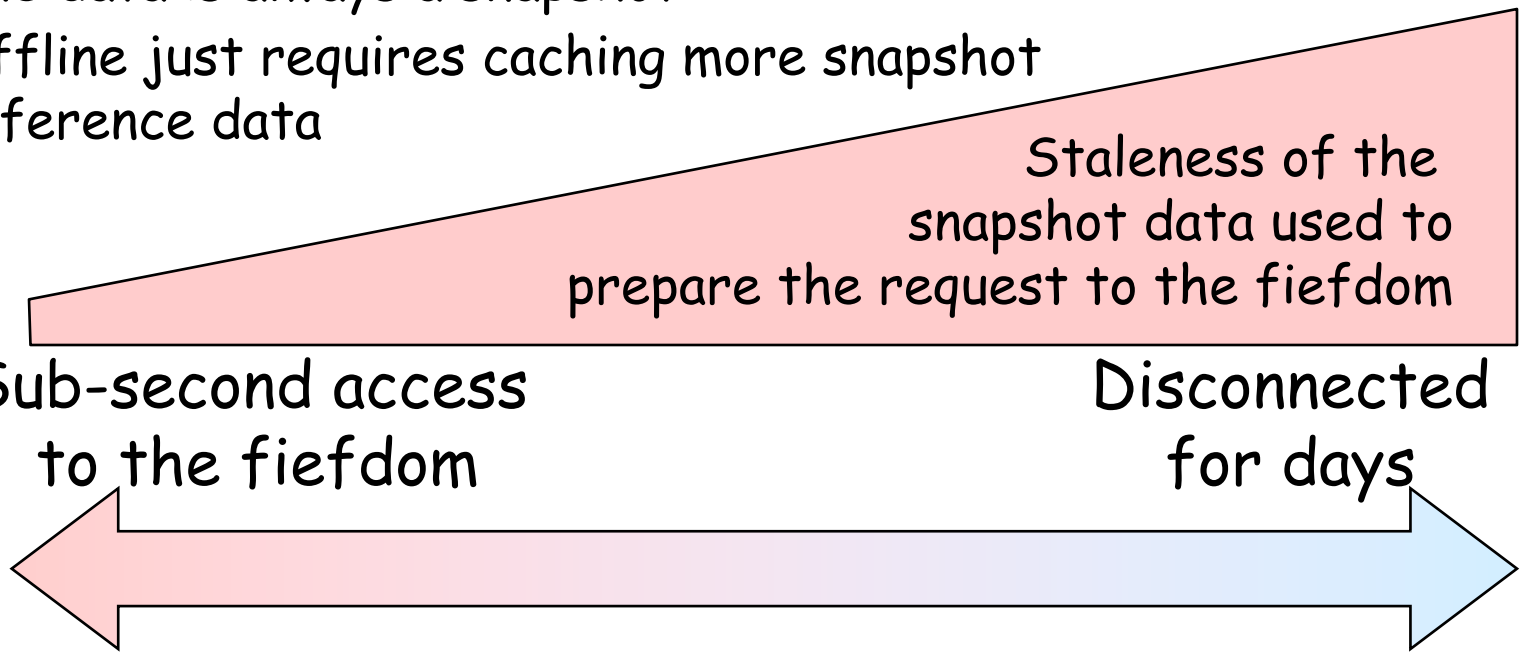
Offline and Online: Points on a Spectrum

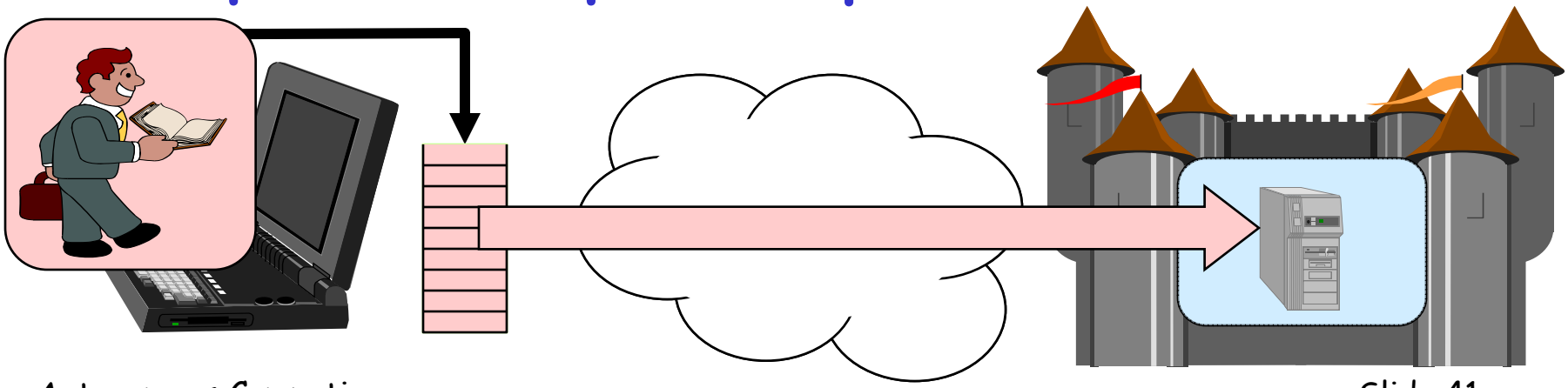
- **All online emissary work is really a flavor of offline**
  - The data is always a snapshot
  - Offline just requires caching more snapshot reference data



- **The fiefdom must cope with stale requests**
  - All requests will be somewhat stale…

Emissaries & Offline Processing

- An emissary works with 2 kinds of data:
  - Snapshots of data published by a fiefdom, and
  - Per-client information
- You can package up an emissary, along with its snapshot data and download it to a smart client
  - On the client, the emissary prepares requests
- Requests are queued up until reconnection



Bringing Enough Content Along

- "Online" applications don't need to bring along snapshot reference data
  - They go fetch it on demand
- Offline applications need to bring reference data with them
  - Organizing what to bring and how to group it together is a new challenge

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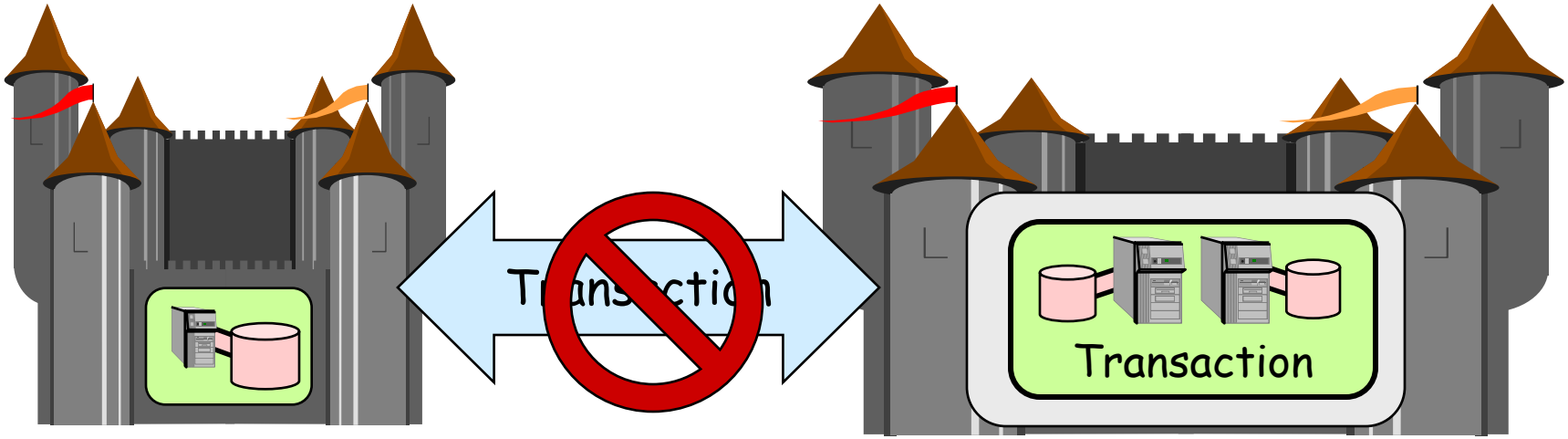
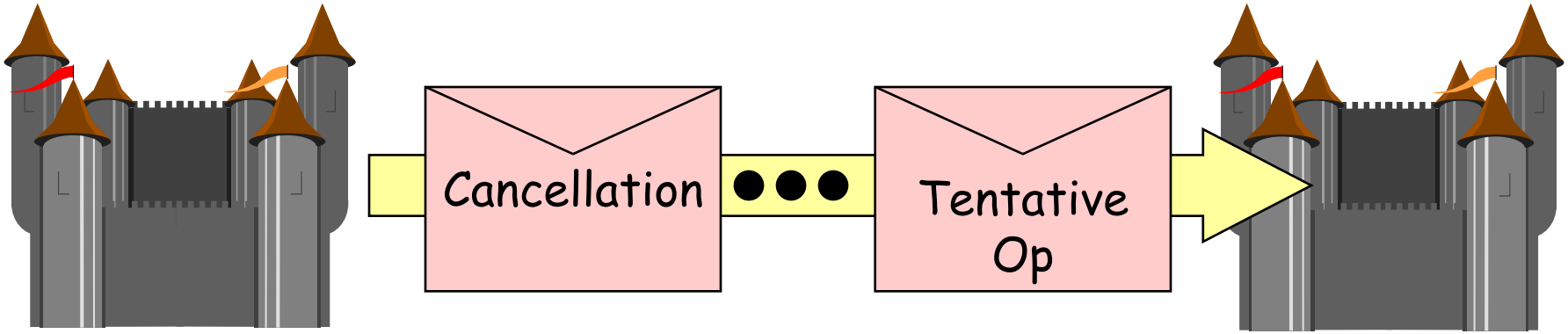
Transactions Don't Work Across Fiefdoms

- Fiefdoms will not agree to share transactions with outsiders
  - No self-respecting fiefdom would hold locks waiting for some other fiefdom
- How can work get coordinated across fiefdoms???



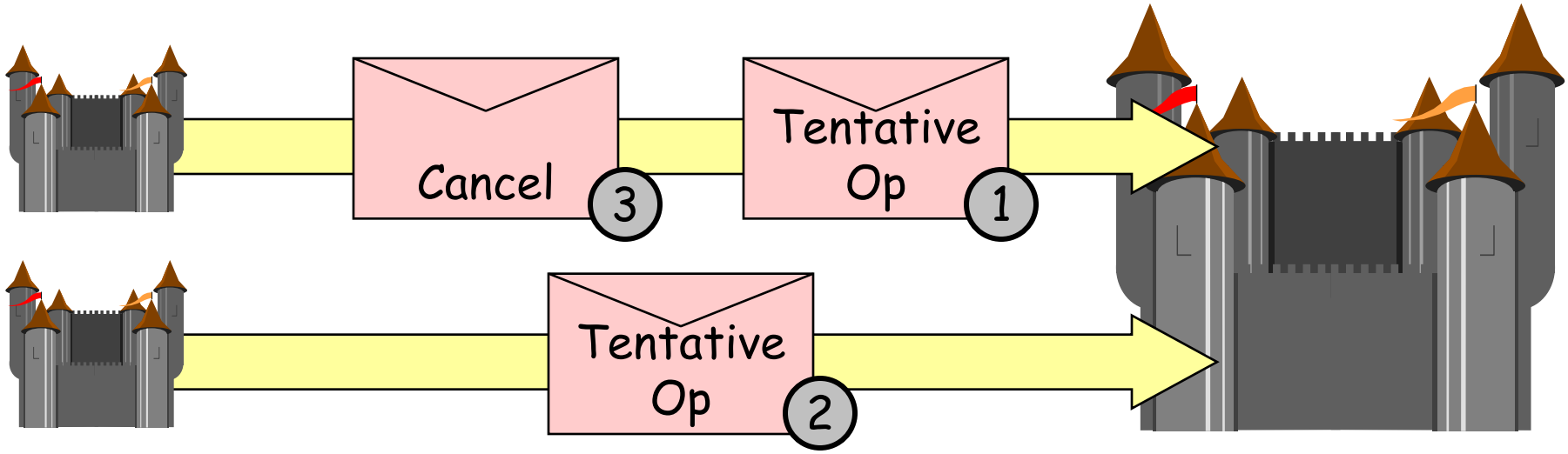
Tentative Operations

- Sometimes fiefdoms will accept requests for tentative operations
  - Similar to a reservation, this can be cancelled later on….
- If the operation is cancelled, the invoked service must deal with the effects



Semantics of Tentative Operations

- **Because a tentative operation may be cancelled later, they must be commutative**
  - Commutative means reorderable…
    - When we cancel, we compensate
    - Other stuff may have happened in between
  - It is important to ensure that the operation and the cancellation are commutative



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Semantics of Cancellation

- **When a tentative operation is cancelled, somehow, the invoked service must compensate for the operation**
  - This is not an undo
  - It is another operation that makes things right…
- **Part of supporting tentative operations is to ensure the operation is cancelable**
  - Again, commutativity is the main technique used to support cancelable operations
    - You can reorder the cancellation with other work

Relinquishing the Right to Cancel

- When an invoking fiefdom chooses to never cancel, it may confirm the operation
  - When you confirm, you give up the right to cancel
- Every tentative operation will be either confirmed or cancelled

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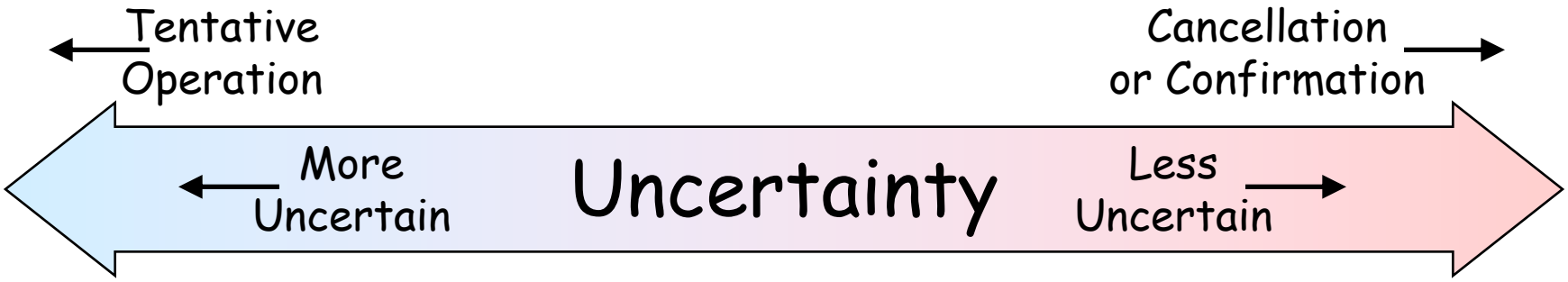
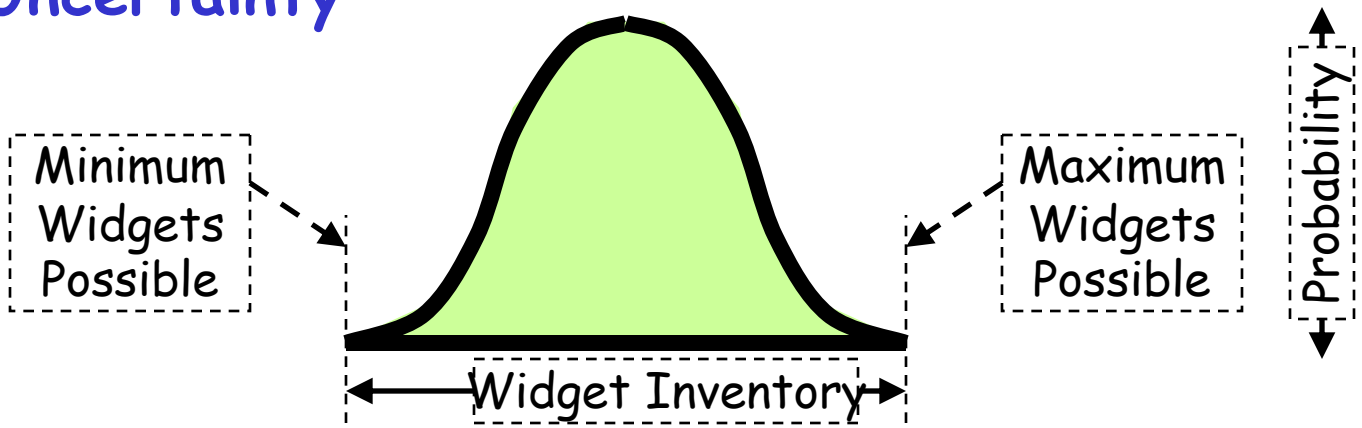
Increasing & Decreasing Uncertainty

- Each tentative operation increases your uncertainty
  - You get more and more confused each time you accept a tentative operation
- Each confirmation or cancellation decreases your uncertainty
  - It resolves the confusion imparted by the tentative operation it is confirming or canceling



Bounded Uncertainty

- **You can track the worst case situations for data values you are managing**
  - If you keep inventory, you can know the lowest possible and highest possible values
  - Tentative operations move lowest and highest values apart
    - This increases uncertainty
  - Confirmations and cancellations move lowest and highest values together
    - This decreases uncertainty
- **Knowing the bounds, you have Bounded Uncertainty**



Acting on Bounded Uncertainty

- **Knowing bounds on uncertainty allows many different business rules:**
  - Refuse an order which may (in the worst case) result in widgets overflowing the warehouse
  - Calculate probability of worst case overflowing the warehouse
    - Cost of temporary storage vs. value of accepting order…
  - Order food for hotel restaurant based on reservations and probabilities
- **May result in interesting work by applying risk management algorithms…**

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Rambling Philosophy…

- **Atomic transaction are singularities**
  - Locking makes them appear to be at a single point in time
  - Two-phase commit removes distribution concerns
- **The new challenges happen when spreading work across space and time**
  - Different fiefdoms are in different spatial locations
  - Work across different messages gets processed at different times
- **Commutativity helps relax space and time**
  - By reordering with acceptable answers, it's OK
    - Note that DB write is not commutative
- **Emissaries don't have concurrency problems**
  - They only deal with read-only and single-user data
  - They make things "stick" by sending requests to fiefdoms
    - The fiefdom must have commutative requests… it sorts out the interleaving of work

Terminology

Autonomous Computing	A style of computing supporting the interaction of independent systems.
Fiefdom	An autonomous computing entity with private data and logic.
Emissary	Code that goes out into the world to assist in working with a fiefdom.
Snapshot Data	A copy of data sent out to an emissary as a references source. For example, a price-list.
Stable Data	Data that doesn't change… it's meaning is clear anytime and anywhere. Appropriate for messages and snapshots.
Bounded Uncertainty	The management of ongoing work to track tentative operations and their confirmation and cancellation.
Idempotent Request	A request message that may be repeatedly processed while still giving behavior the same as a single execution. Essential to cope with retries…

Summary

- **Autonomous Computing**
  - Allows distrusting systems to cooperate
  - Defines a framework for the distribution of data to use in messages
  - Loosely-coupled collections of tightly coupled services
  - Explains web, offline, B2B, B2C, long-running work, etc.