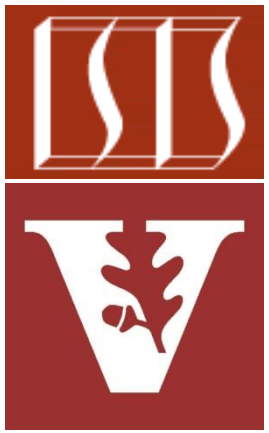
Barrier Synchronization: Introduction



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Learning Objectives in this Part of the Lesson

- Understand what barrier synchronization is & know three different ways of using barrier synchronizers

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- Understand what barrier synchronization is & know three different ways of using barrier synchronizers
- Note a human known use of barrier synchronization

Overview of Barrier Synchronization

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- Earlier discussions of Java synchronizers have largely focused on classes that affect the behavior of individual threads

See earlier lesson on "*Types of Java Synchronizer Capabilities*"

Overview of Barrier Synchronization

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  - Atomic operations are actions that happen effectively all at once or not at all

See earlier lessons on "*Java Atomic Operations & Classes*"

Overview of Barrier Synchronization

- Earlier discussions of Java synchronizers have largely focused on classes that affect the behavior of individual threads, e.g.
  - Atomic operations are actions that happen effectively all at once or not at all
  - Mutual exclusion synchronizers allow concurrent access & updates to shared mutable data within critical sections

See earlier lessons on "*Java ReentrantLock*", "*Java Semaphore*", "*Java ReentrantReadWriteLock*", "*Java StampedLock*", & "*Java Monitor Objects*"

Overview of Barrier Synchronization

- Earlier discussions of Java synchronizers have largely focused on classes that affect the behavior of individual threads, e.g.
  - Atomic operations are actions that happen effectively all at once or not at all
  - Mutual exclusion synchronizers allow concurrent access & updates to shared mutable data within critical sections
  - Coordination synchronizers ensure that computations run properly
    - e.g., in the right order, at the right time, under the right conditions, etc.

See earlier lessons on "*Java ConditionObject*" & "*Java Monitor Objects*"

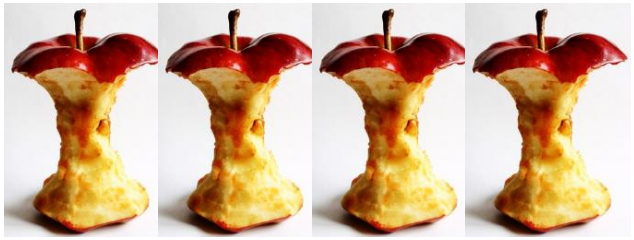
Overview of Barrier Synchronization

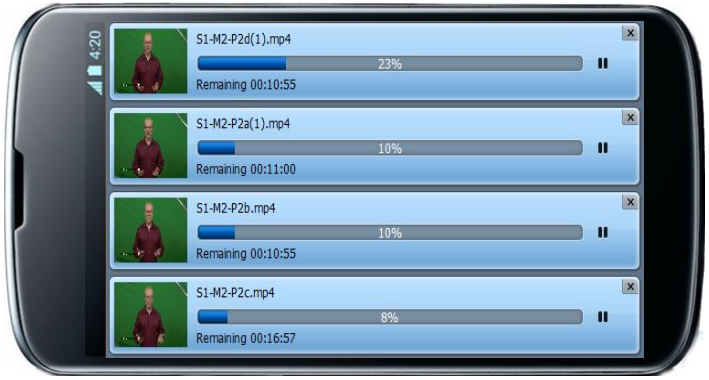
- In contrast, a barrier is a synchronizer that ensures thread(s) must stop at a certain point & cannot proceed until all other thread(s) reach this barrier

See en.wikipedia.org/wiki/Barrier_(computer_science)

Overview of Barrier Synchronization

- Barriers can be used in three ways





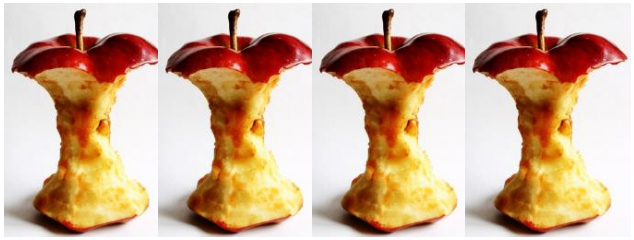
We'll use an video rendering engine as a running example in this part of the lesson

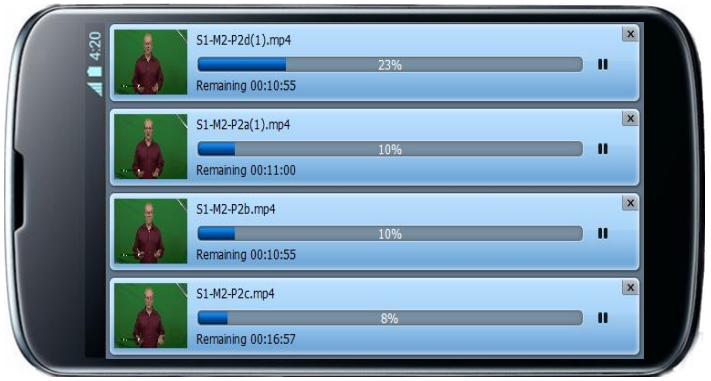
Overview of Barrier Synchronization

- Barriers can be used in three ways

A. Entry barrier

  - e.g., keep concurrent computations from running until object(s) are fully initialized





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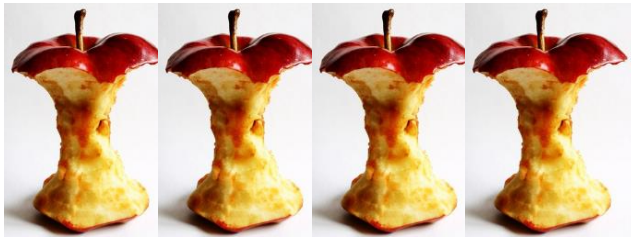

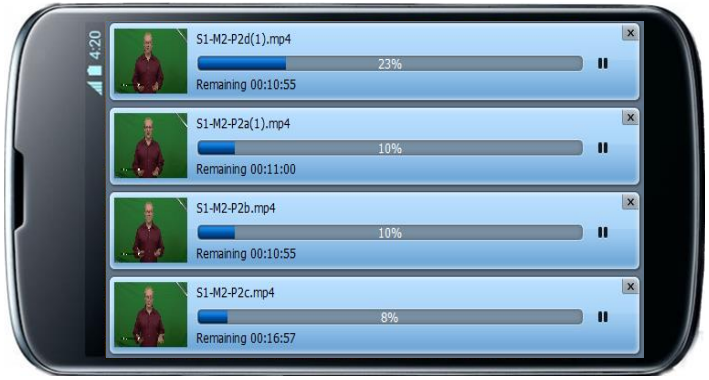

Main thread spawns some # of worker threads & then performs some time-consuming initialization of data structures

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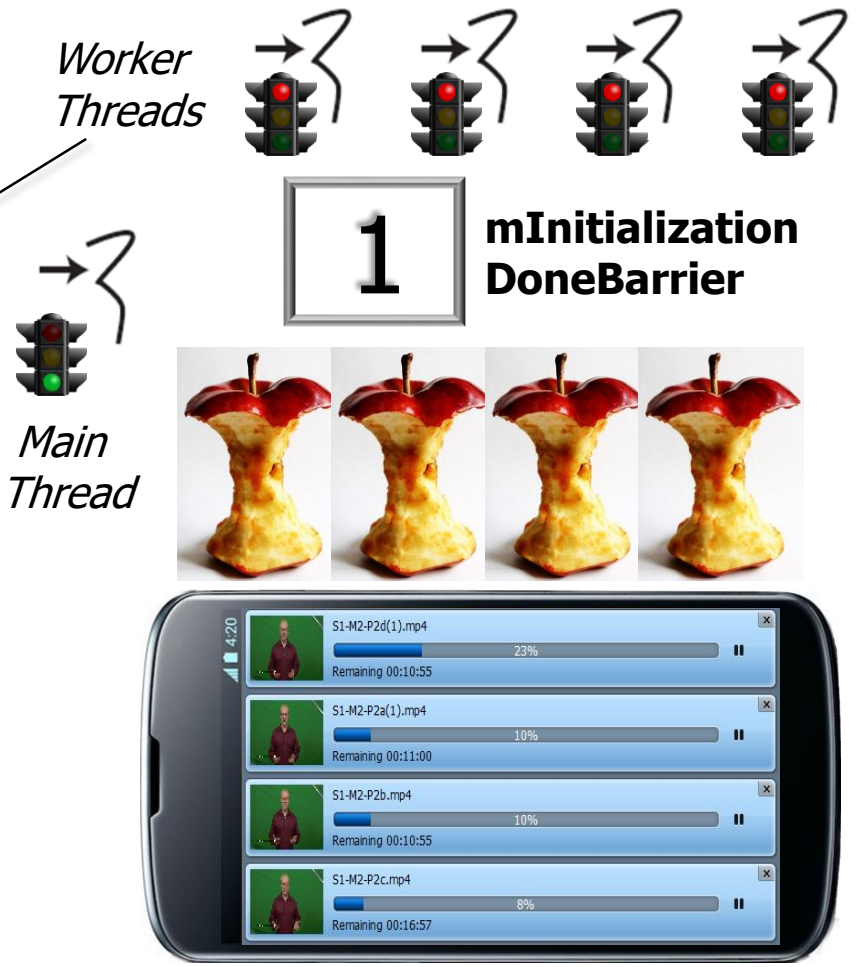

The worker threads wait on the entry barrier until the main thread completes its initializations

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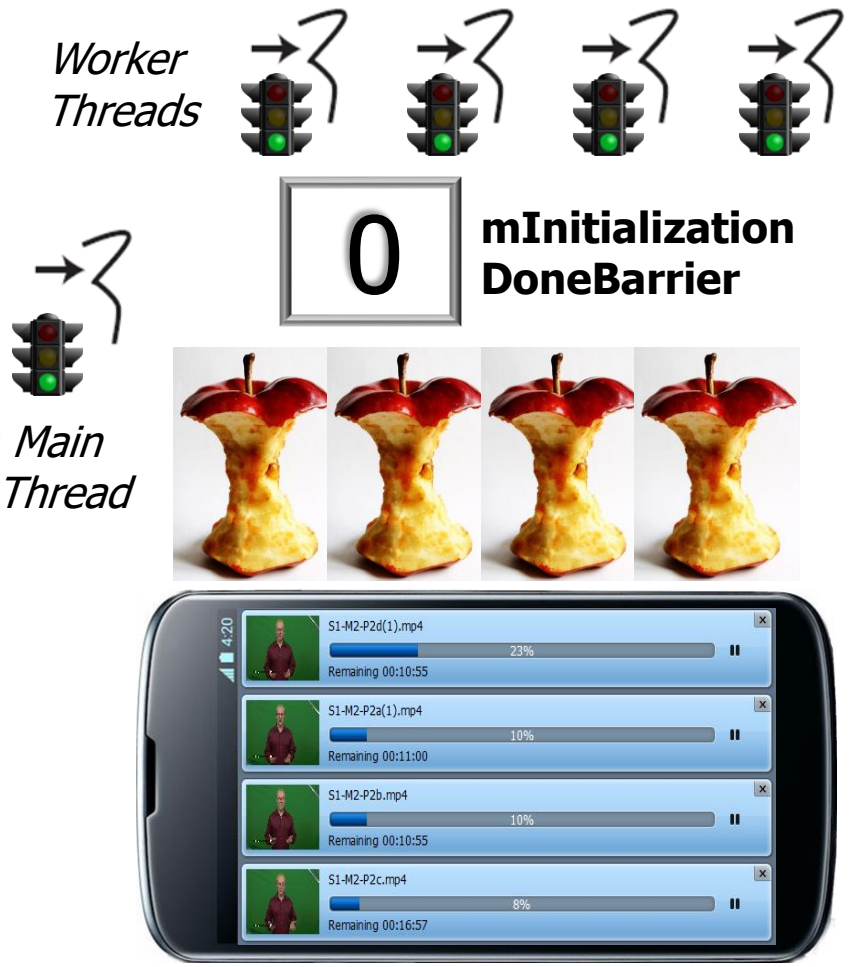


The main thread decrements the entry barrier to 0, thereby informing worker threads they can continue

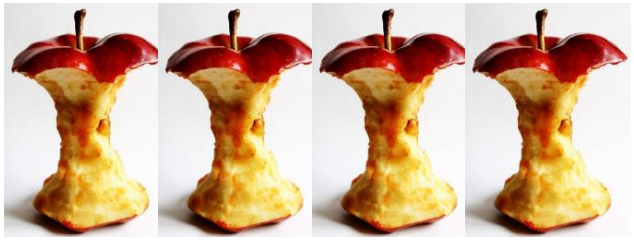
Overview of Barrier Synchronization

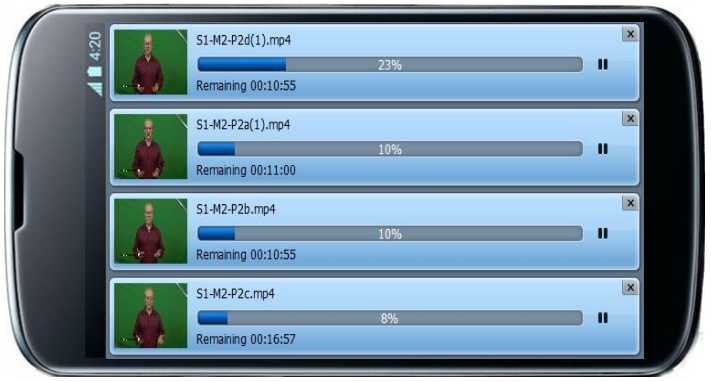
- Barriers can be used in three ways

  A. Entry barrier

  B. Exit barrier

  - e.g., don't let a thread continue until a group of concurrent threads have finished their processing





Overview of Barrier Synchronization

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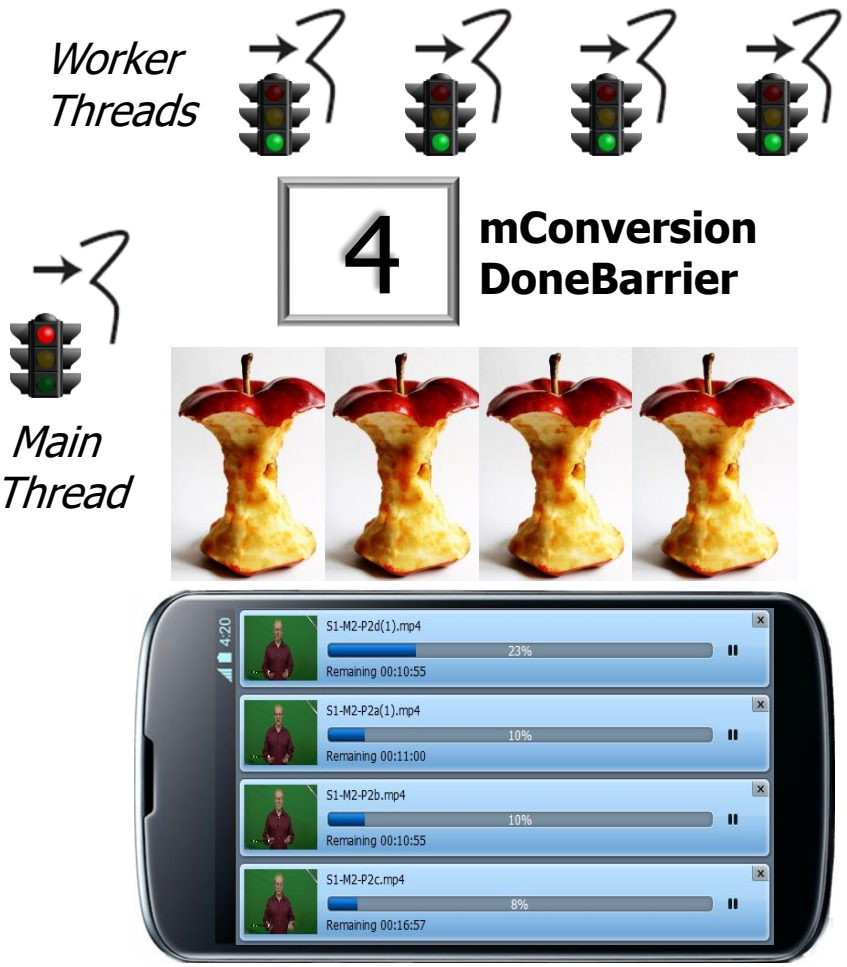

The main thread waits on an exit barrier for all worker threads to finish

Overview of Barrier Synchronization

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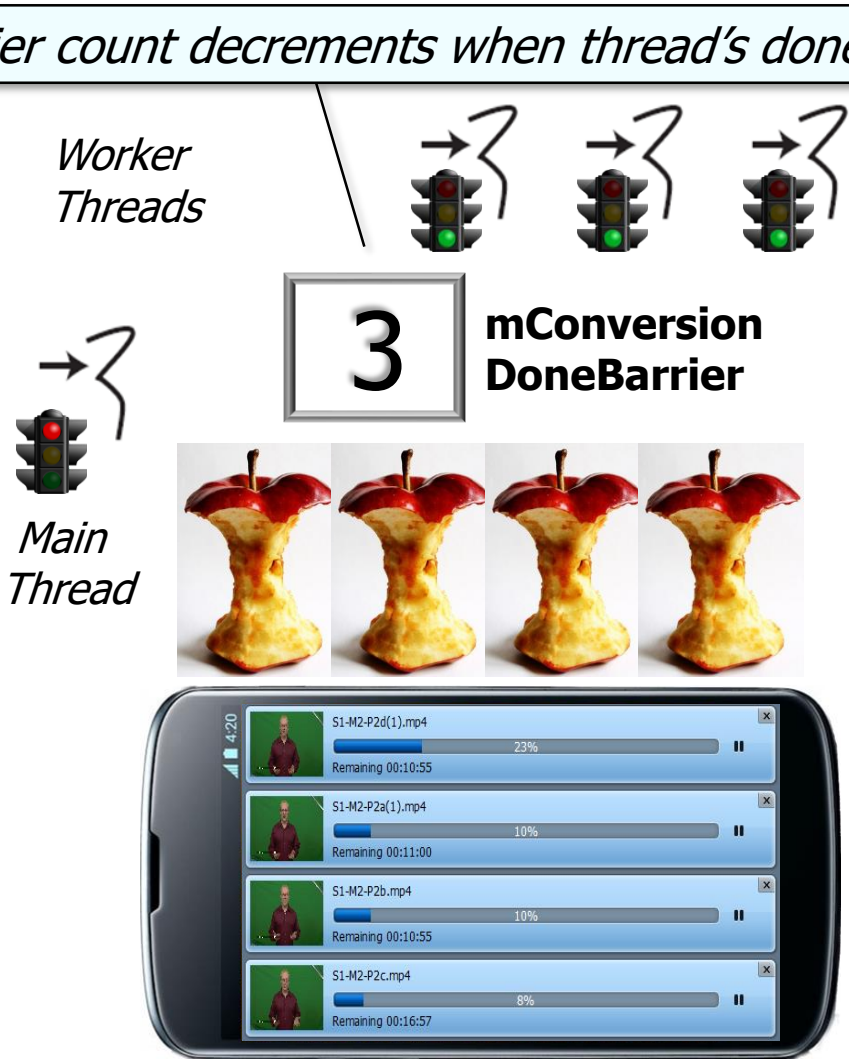

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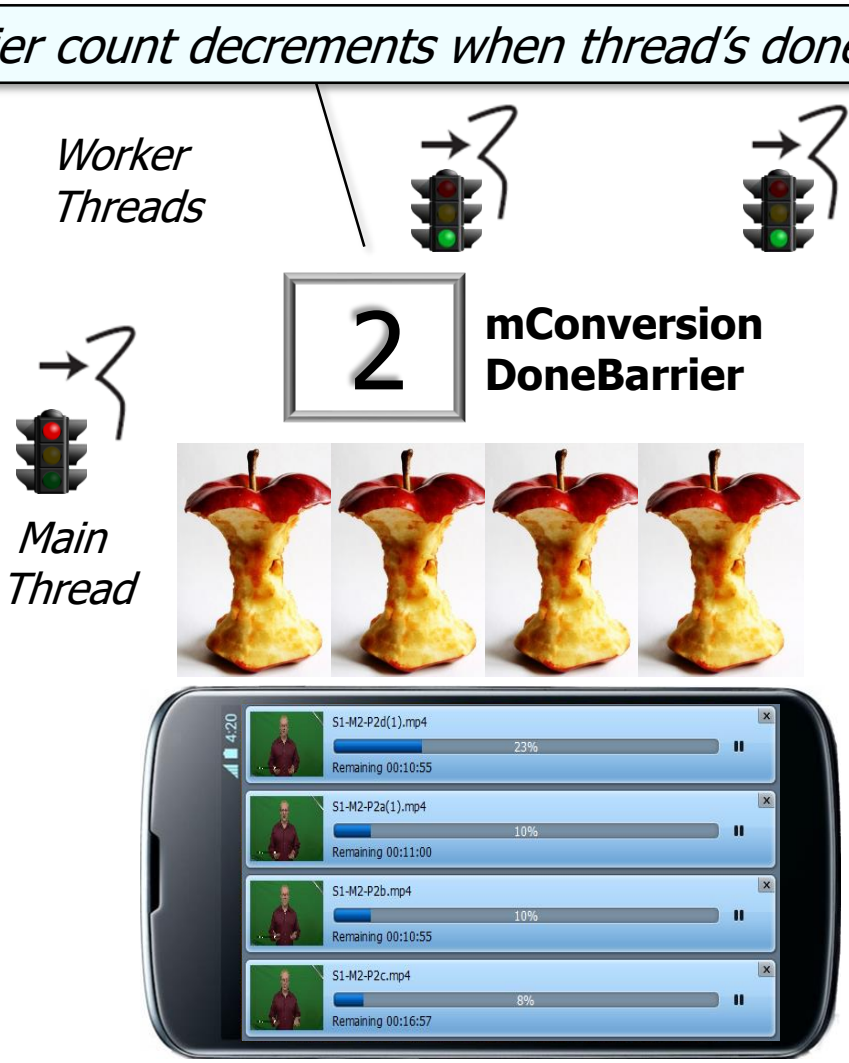

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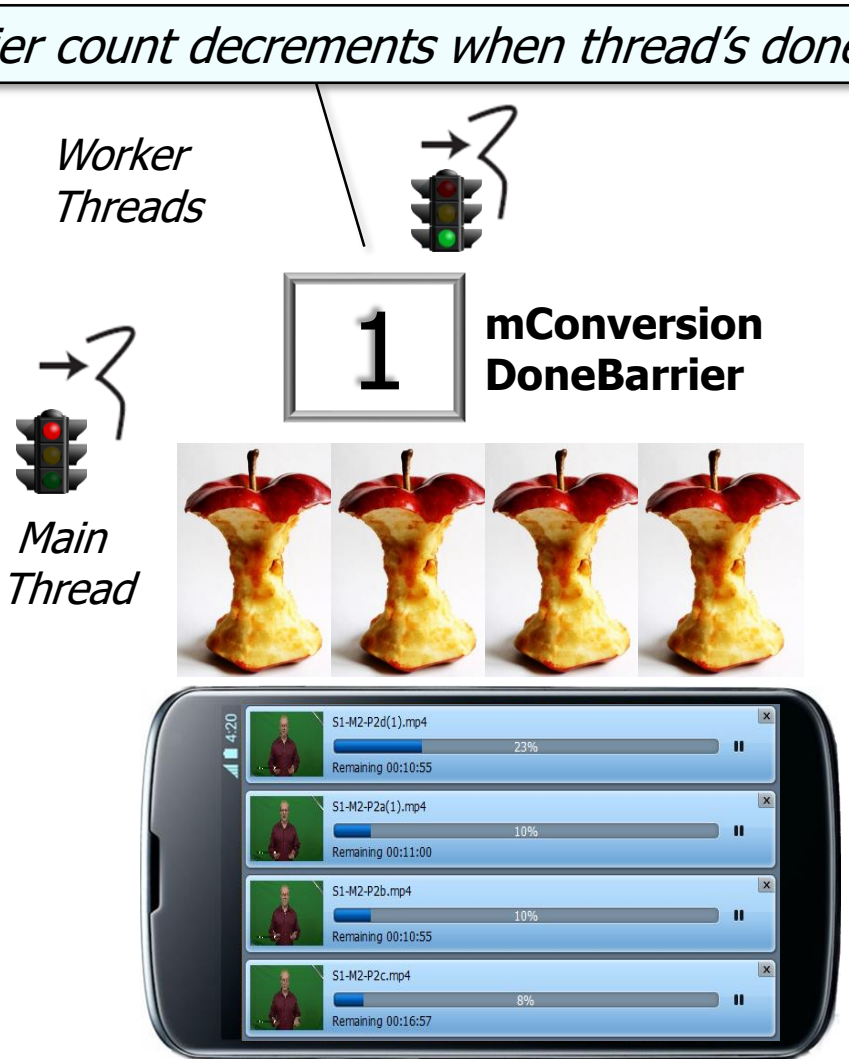

Overview of Barrier Synchronization

- Barriers can be used in three ways

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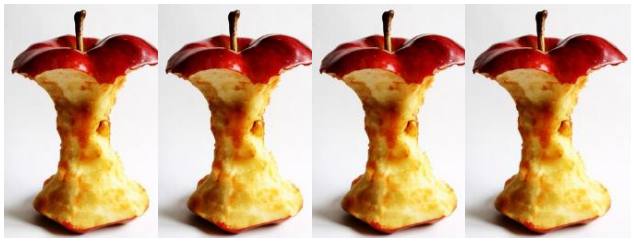
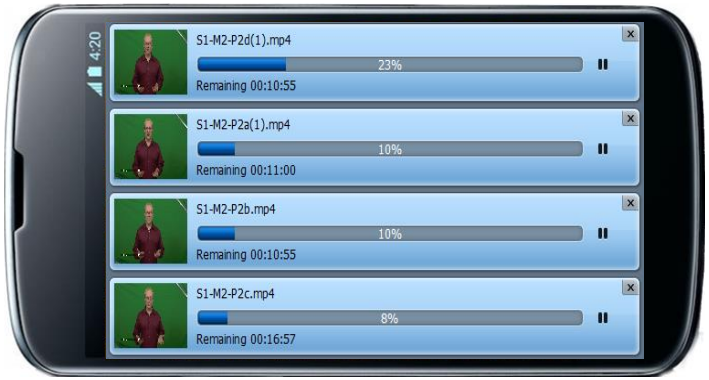
Main Thread

mConversion DoneBarrier

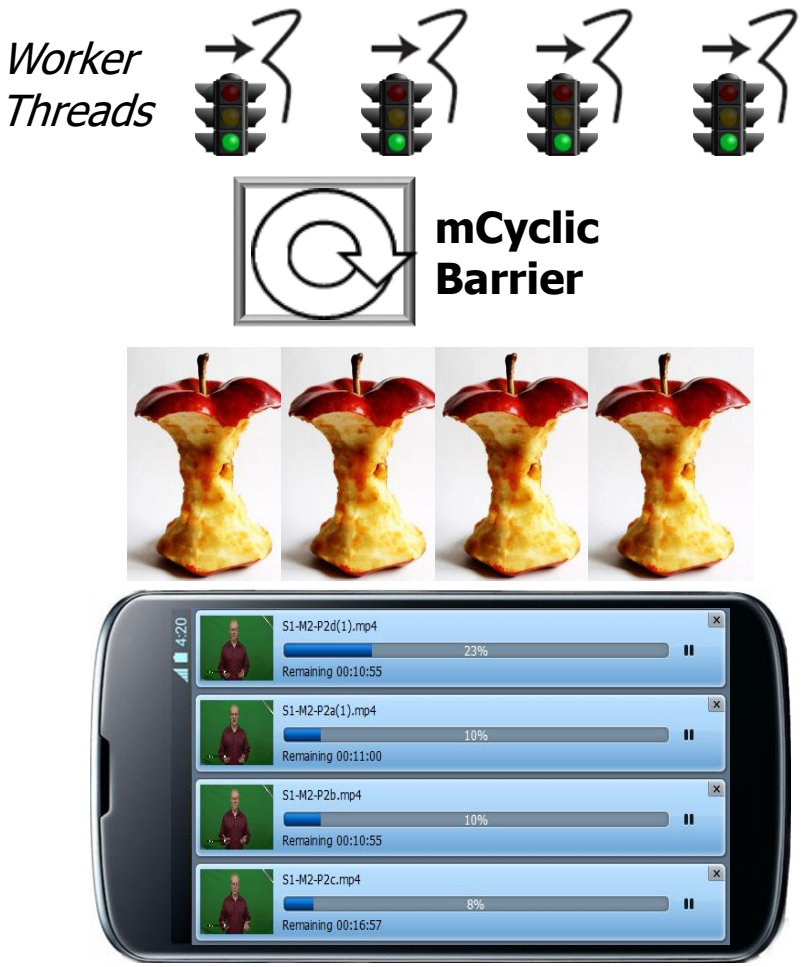




When the exit barrier count = 0 the main thread can now continue

Overview of Barrier Synchronization

- Barriers can be used in three ways
  - A. Entry barrier
  - B. Exit barrier
  - **C. Cyclic barrier**
    - e.g., a group of threads all wait for each other to reach a certain point before advancing to the next cycle



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A fixed- or variable-size pool of threads can run concurrently

Overview of Barrier Synchronization

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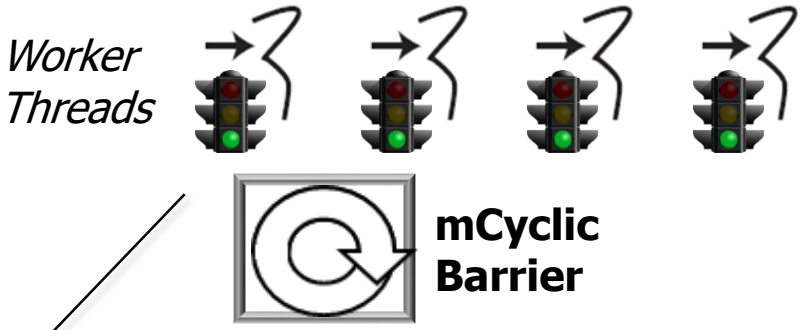
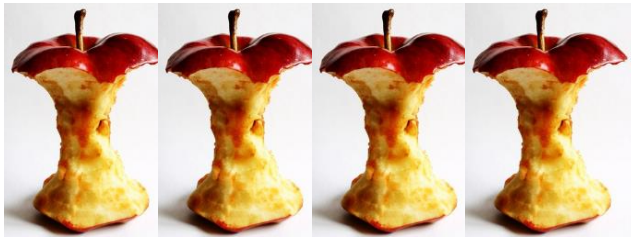
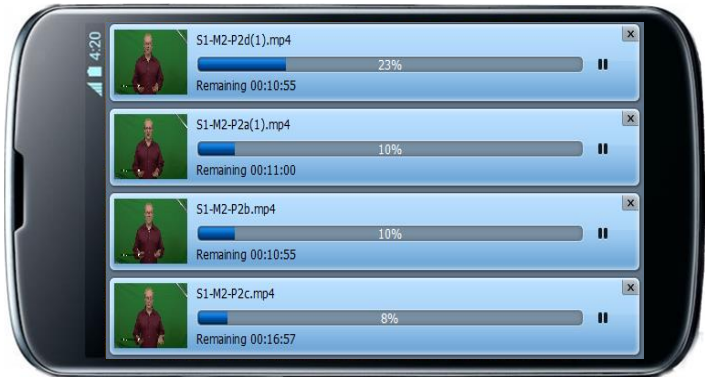
  - B. Exit barrier
  - **C. Cyclic barrier**
    - e.g., a group of threads all wait for each other to reach a certain point before advancing to the next cycle

At the end of each cycle a decision is made about whether to continue or not







Human Known Uses of Barrier Synchronization

Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide

See en.wikipedia.org/wiki/Tour_guide

Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide

  A. Entry barrier

  - Tourists wait outside museum until it opens or until a tour is schedule to begin

Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide

  A. Entry barrier

  B. Exit barrier

  - The museum closes only after last group of tourists leave

Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide
  - A. Entry barrier
  - B. Exit barrier
  - **C. Cyclic barrier**
    - Tour guide waits for all the tourists to finish exploring a room before continuing the tour in next room

Cyclic barriers can be used either as entry or exit barriers

Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide
  - **A. Entry barrier**
  - **B. Exit barrier**
  - **C. Cyclic barrier**

Barriers can be used for both fixed- & variable-sized number of tourists

End of Barrier Synchronization: Introduction