Presentation Slides

Appendix A
Logically Determined Wavefront Flow

Logically Determined Design:
Clockless System Design With NULL Convention Logic

by Karl Fant

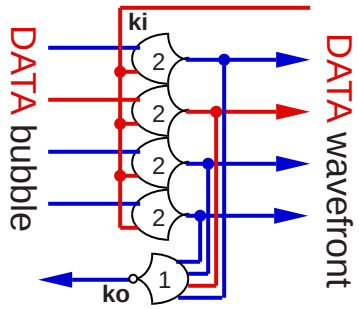
John Wiley & Sons, Inc.

Introduce the behavior of asynchronously flowing wavefronts

Definitions

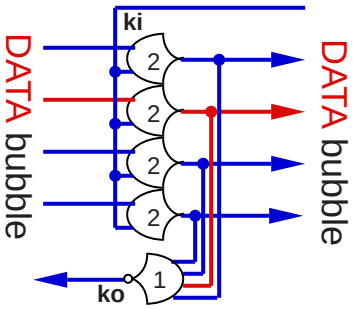
DATA wavefront

DATA in a cycle enabled for DATA is a DATA wavefront. It is stably maintained and a NULL wavefront cannot overwrite it.



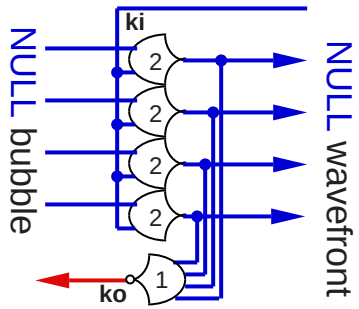
DATA bubble

DATA in a cycle enabled for NULL is a DATA bubble and a NULL wavefront can overwrite it.



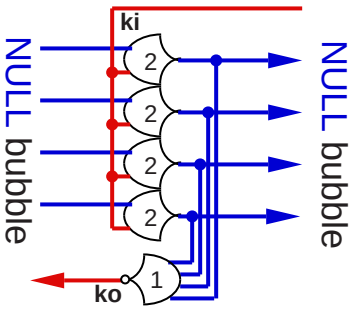
NULL wavefront

NULL in a cycle enabled for NULL is a NULL wavefront. It is stably maintained and a DATA wavefront cannot overwrite it.

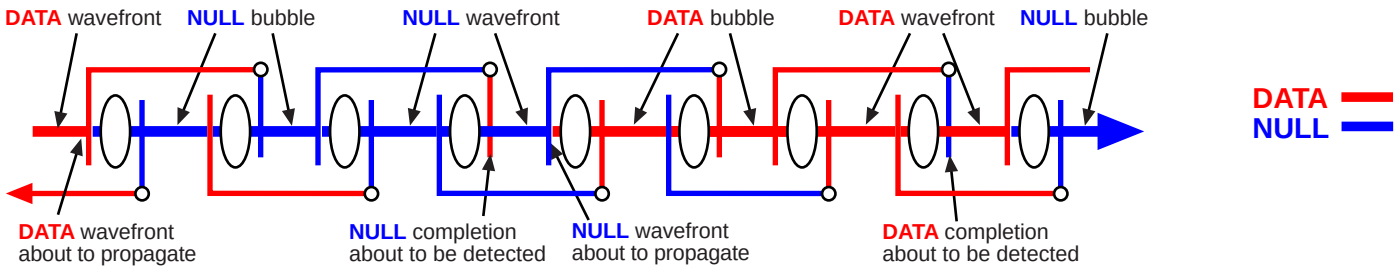


NULL bubble

NULL in a cycle enabled for DATA is a NULL bubble and a DATA wavefront can overwrite it.

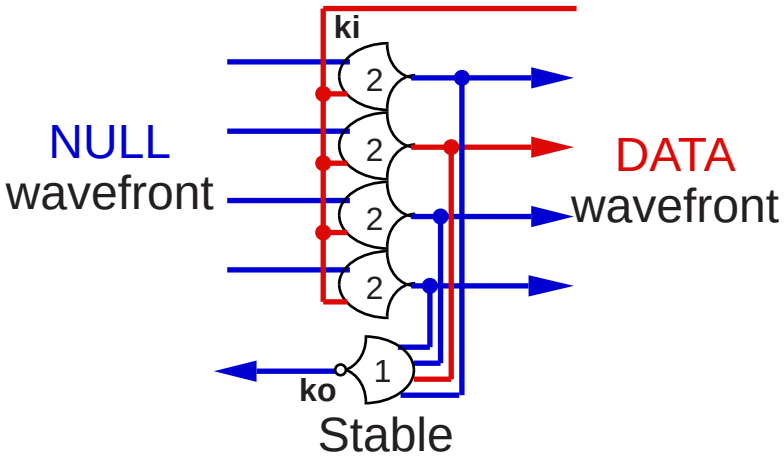


Labeled pipeline stages

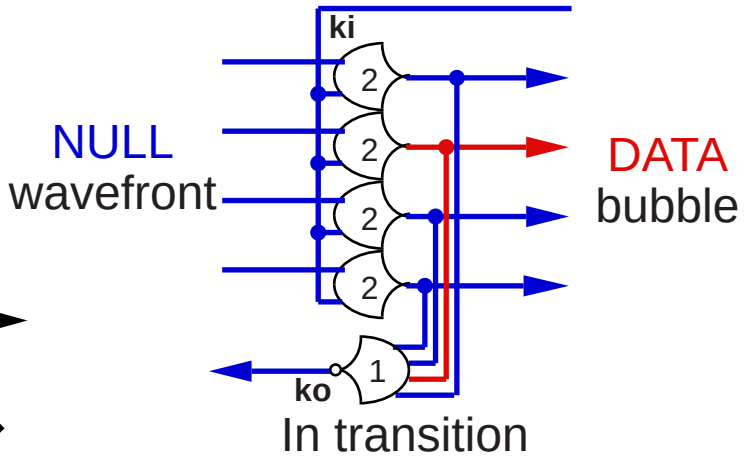


The NULL Wavefront Arrives Before the Request for NULL

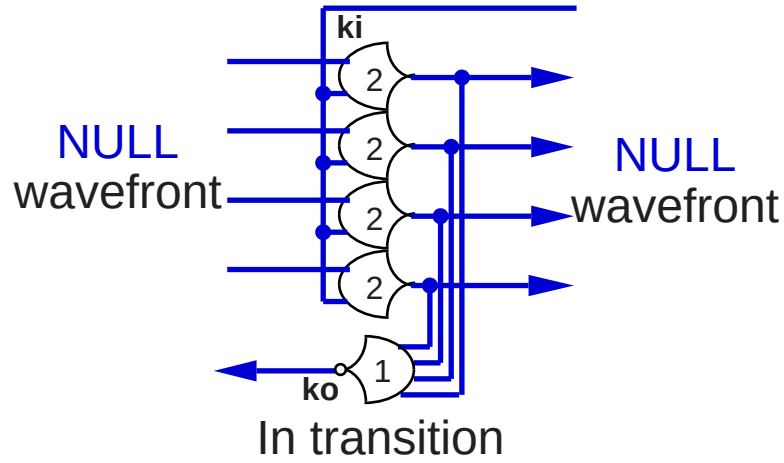
The NULL wavefront arrives before the request for NULL and is blocked



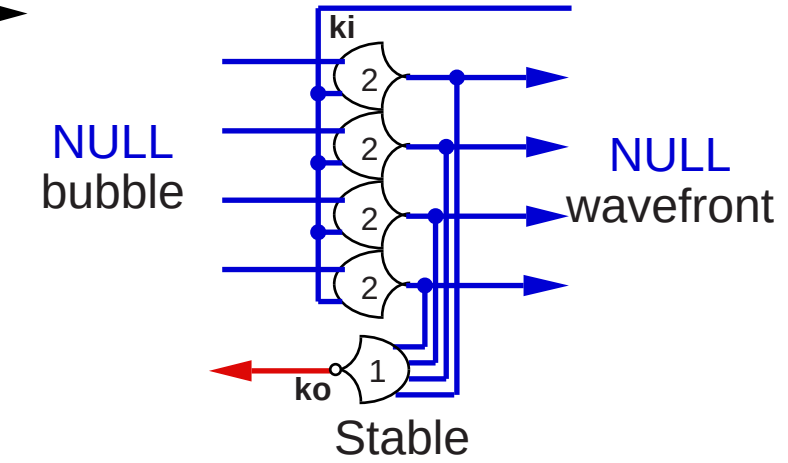
The request for NULL arrives and the NULL wavefront begins flowing



The stage passes and stores the NULL wavefront

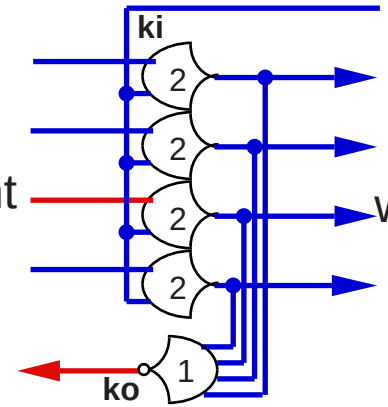


The stage detects completeness and transitions acknowledge creating a NULL bubble



The DATA Wavefront Arrives Before the Request for DATA

The DATA wavefront arrives before the request for DATA and is blocked

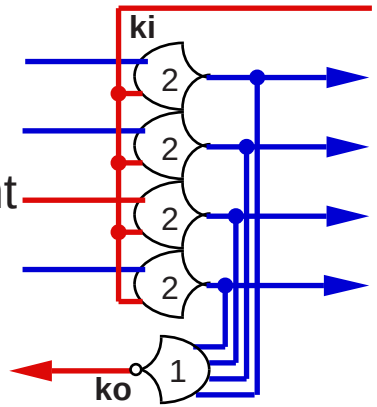


DATA wavefront

NULL wavefront

Stable

The request for DATA arrives and the DATA wavefront begins flowing

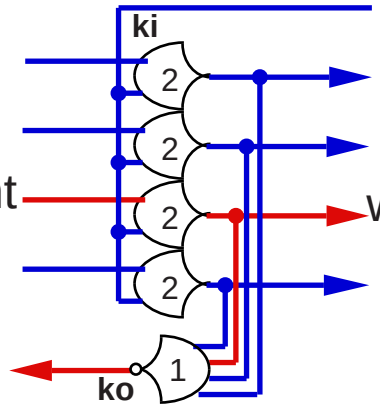


DATA wavefront

NULL bubble

In transition

The stage passes and stores the DATA wavefront

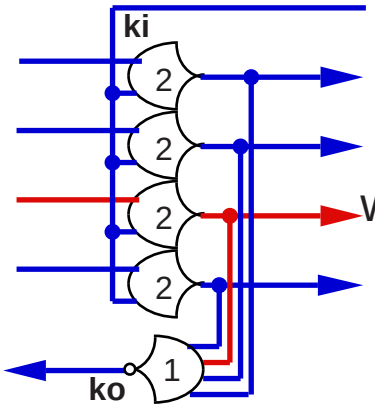


DATA wavefront

DATA wavefront

In transition

The stage detects completeness and transitions acknowledge creating a DATA bubble



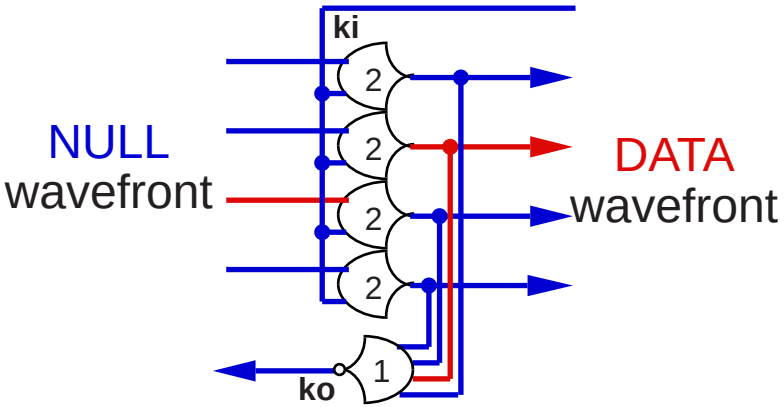
DATA bubble

DATA wavefront

Stable

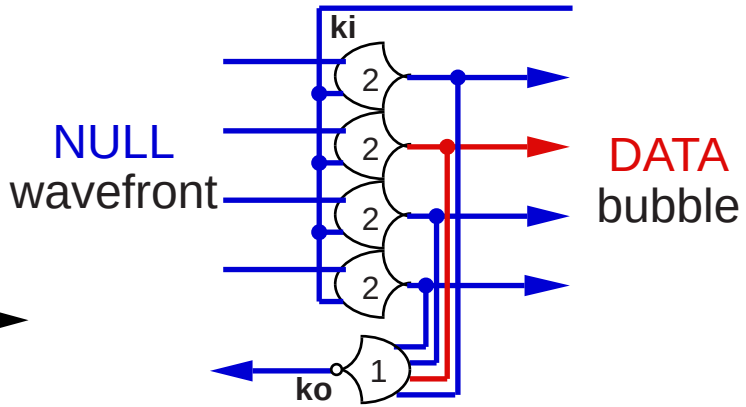
The Request for NULL Arrives Before the NULL wavefront

The request for NULL arrives before the NULL wavefront and awaits a NULL wavefront



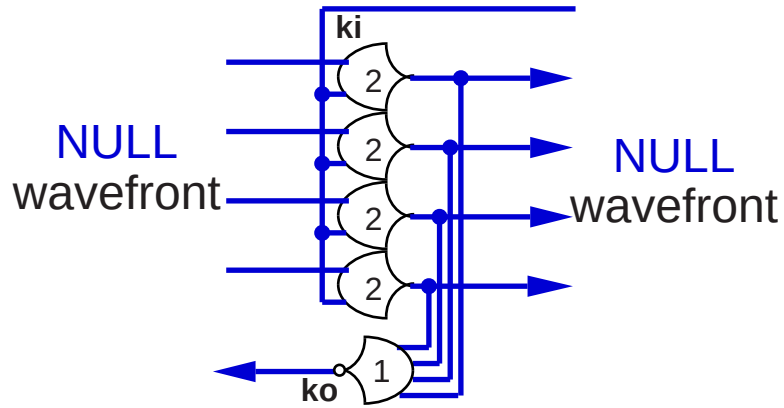
Stable

The NULL wavefront arrives and begins flowing through the stage



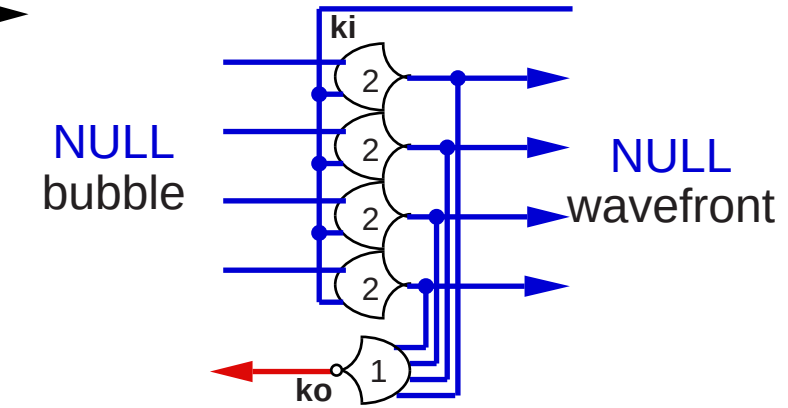
In transition

The stage passes and stores the NULL wavefront



In transition

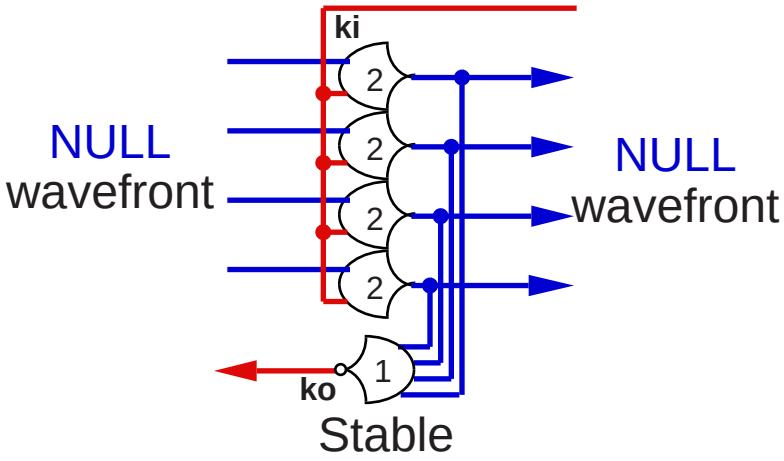
The stage detects completeness and transitions acknowledge creating a NULL bubble



Stable

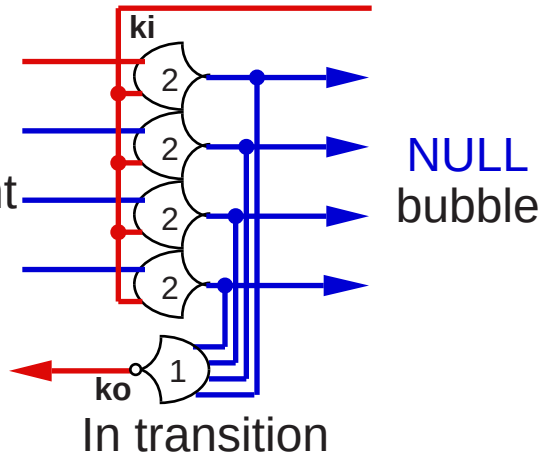
The Request for DATA Arrives Before the DATA Wavefront

The request for DATA arrives before the DATA wavefront and awaits a DATA wavefront



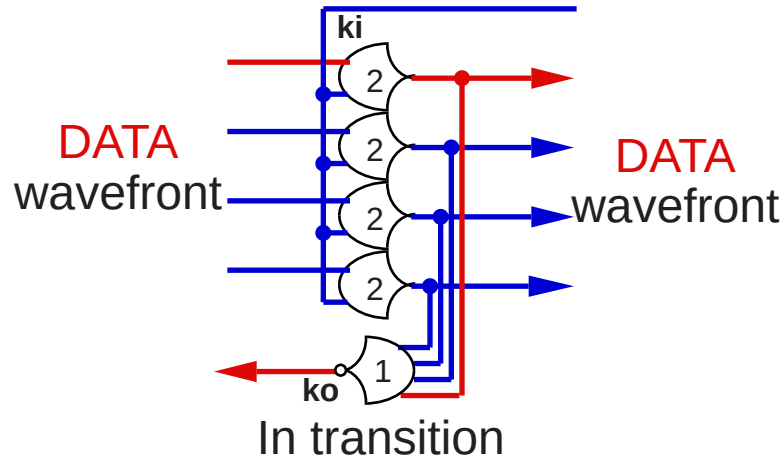
Stable

The DATA wavefront arrives and the DATA wavefront begins flowing through the stage



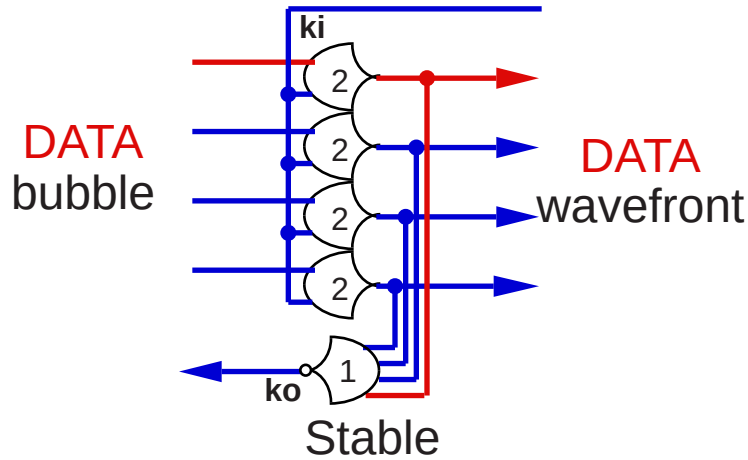
In transition

The stage passes and stores the DATA wavefront

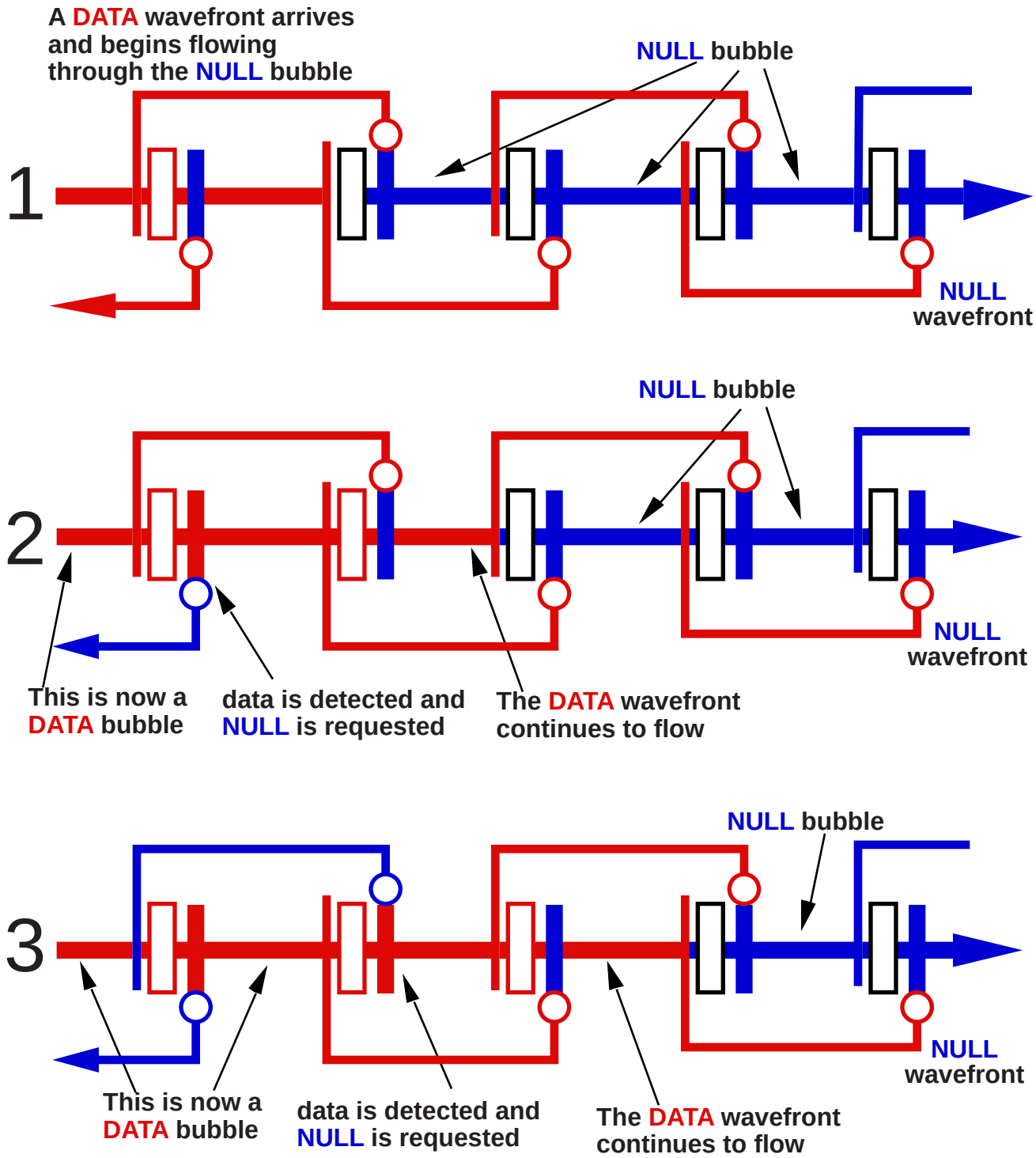


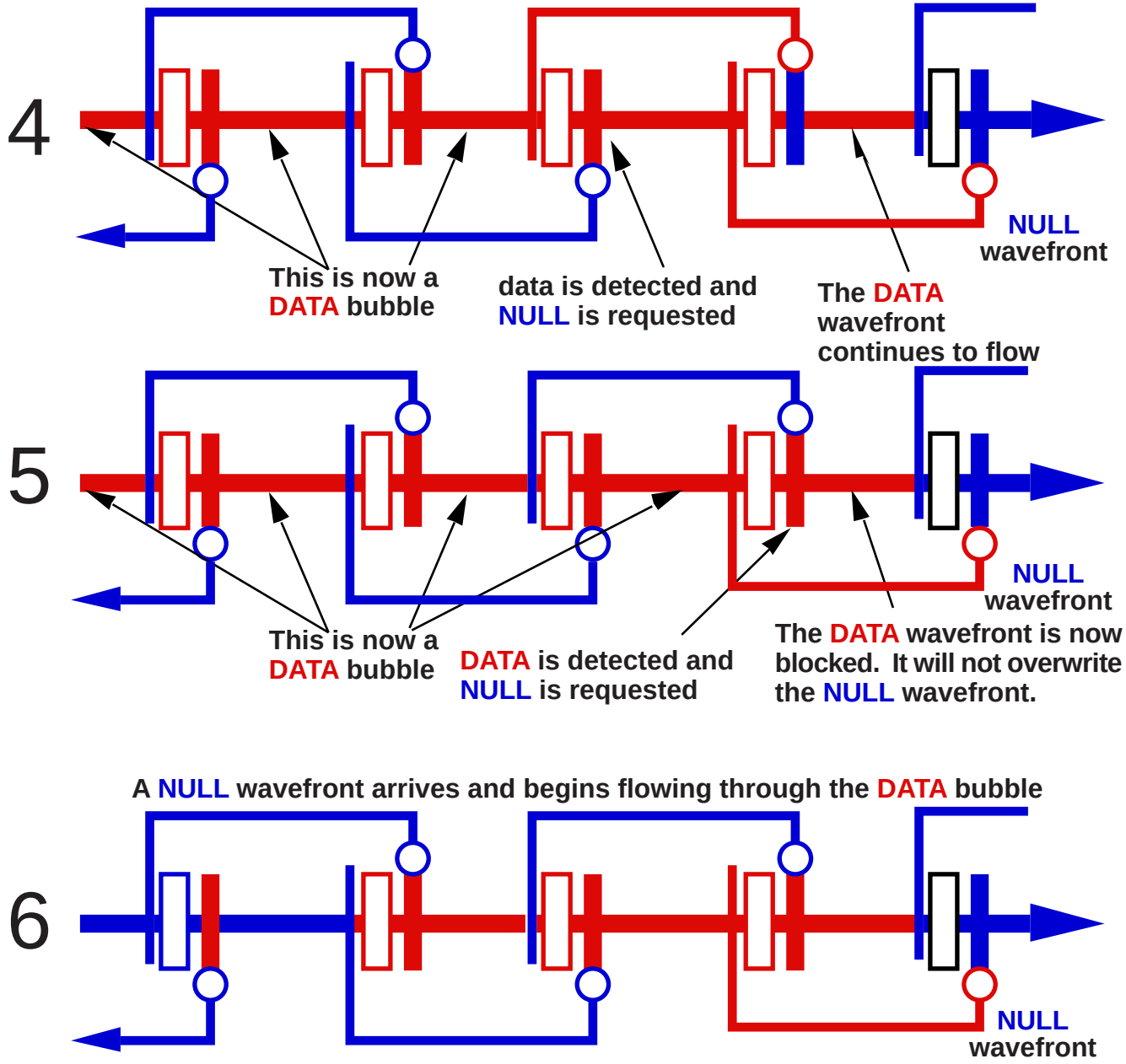
In transition

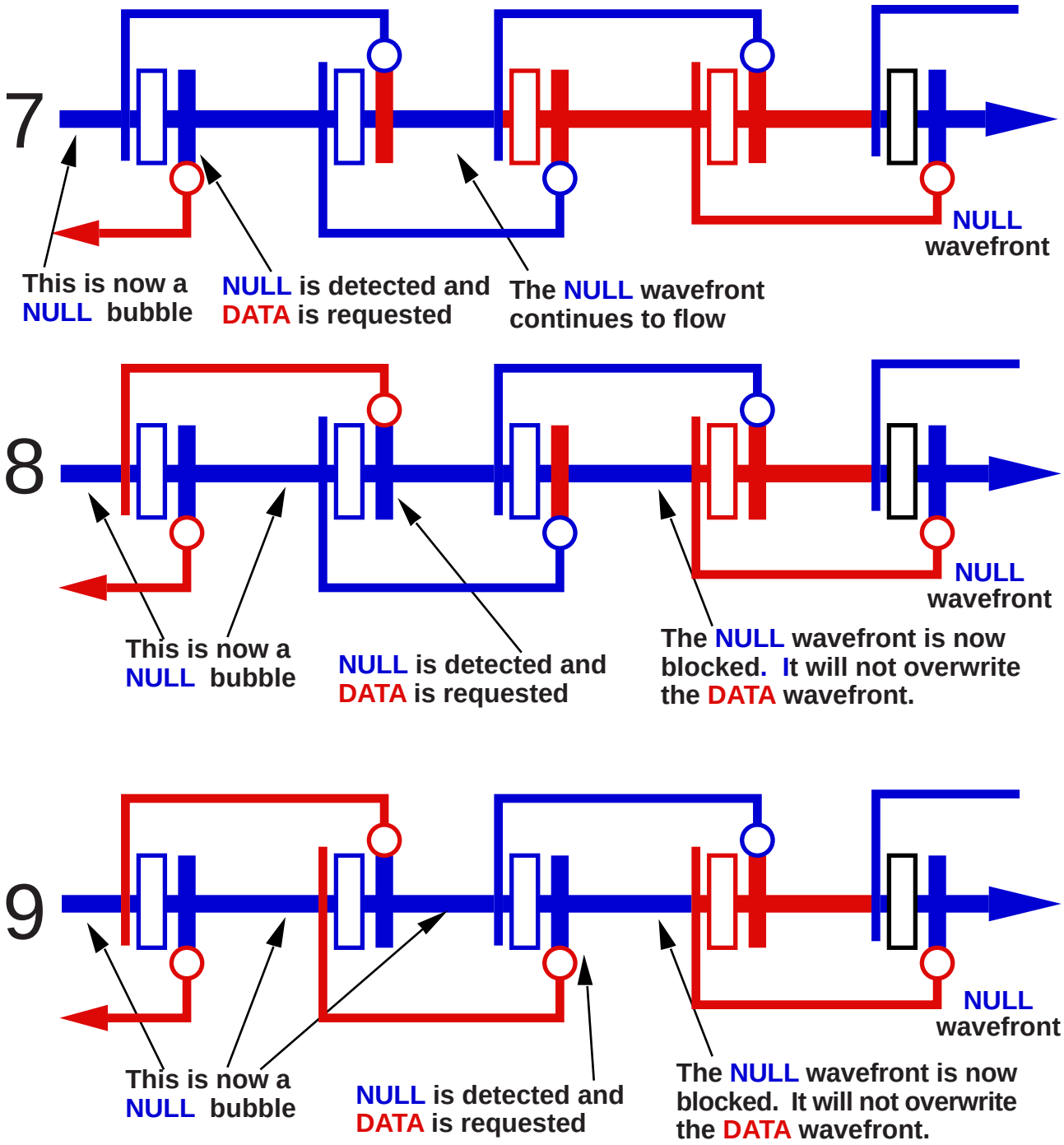
The stage detects completeness and transitions acknowledge creating a DATA bubble



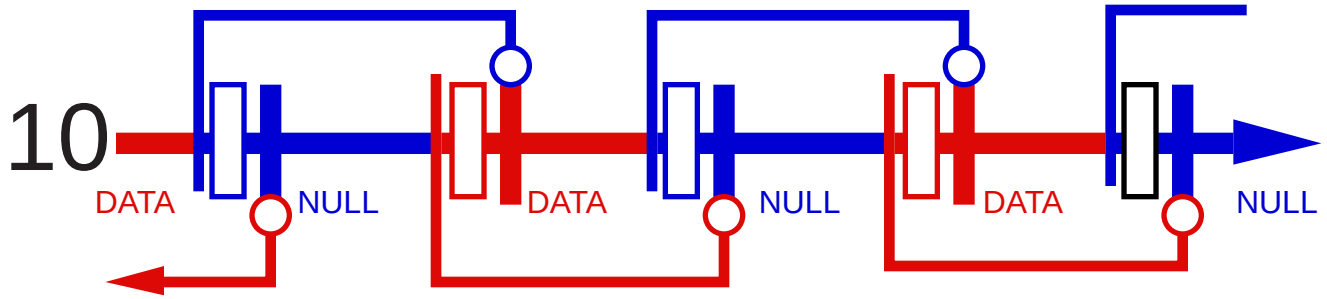
Stable


A DATA wavefront arrives and begins flowing through the NULL bubble
NULL bubble
1
NULL wavefront
NULL bubble
2
NULL wavefront
This is now a DATA bubble
data is detected and NULL is requested
The DATA wavefront continues to flow
NULL bubble
3
NULL wavefront
This is now a DATA bubble
data is detected and NULL is requested
The DATA wavefront continues to flow

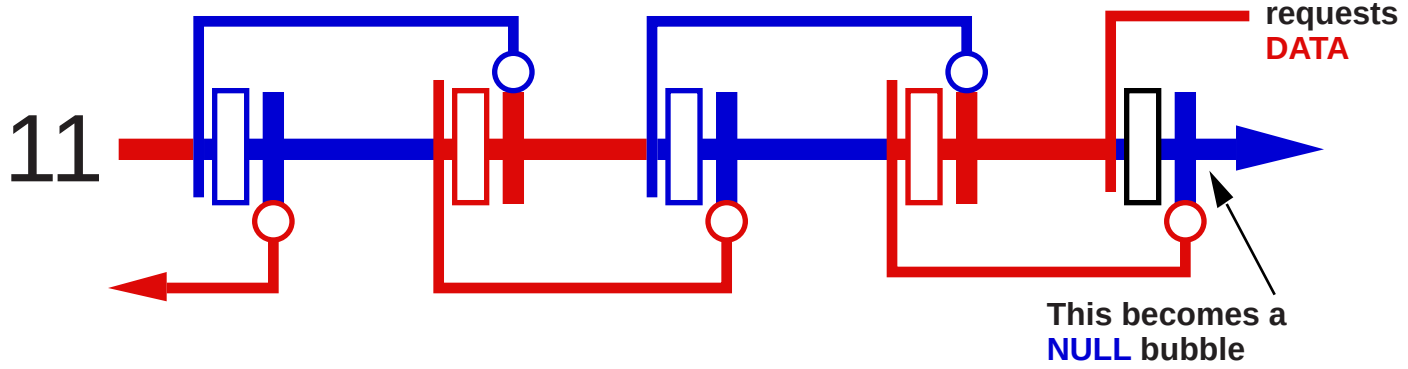

4
NULL
wavefront
This is now a
DATA bubble
data is detected and
NULL is requested
The DATA
wavefront
continues to flow
5
NULL
wavefront
This is now a
DATA bubble
DATA is detected and
NULL is requested
The DATA wavefront is now
blocked. It will not overwrite
the NULL wavefront.
A NULL wavefront arrives and begins flowing through the DATA bubble
6
NULL
wavefront

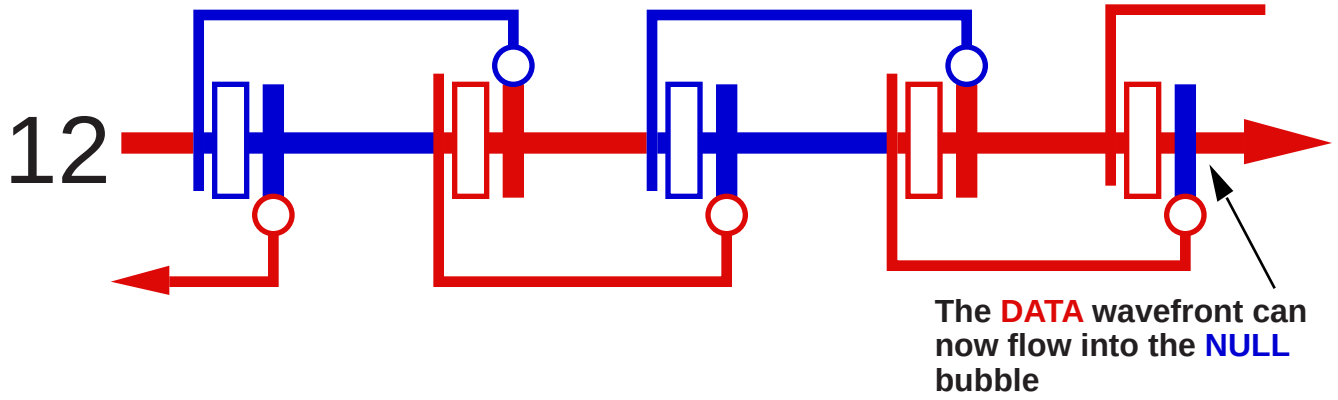

7
This is now a NULL bubble
NULL is detected and DATA is requested
The NULL wavefront continues to flow
NULL wavefront
8
This is now a NULL bubble
NULL is detected and DATA is requested
The NULL wavefront is now blocked. It will not overwrite the DATA wavefront.
NULL wavefront
9
This is now a NULL bubble
NULL is detected and DATA is requested
The NULL wavefront is now blocked. It will not overwrite the DATA wavefront.
NULL wavefront

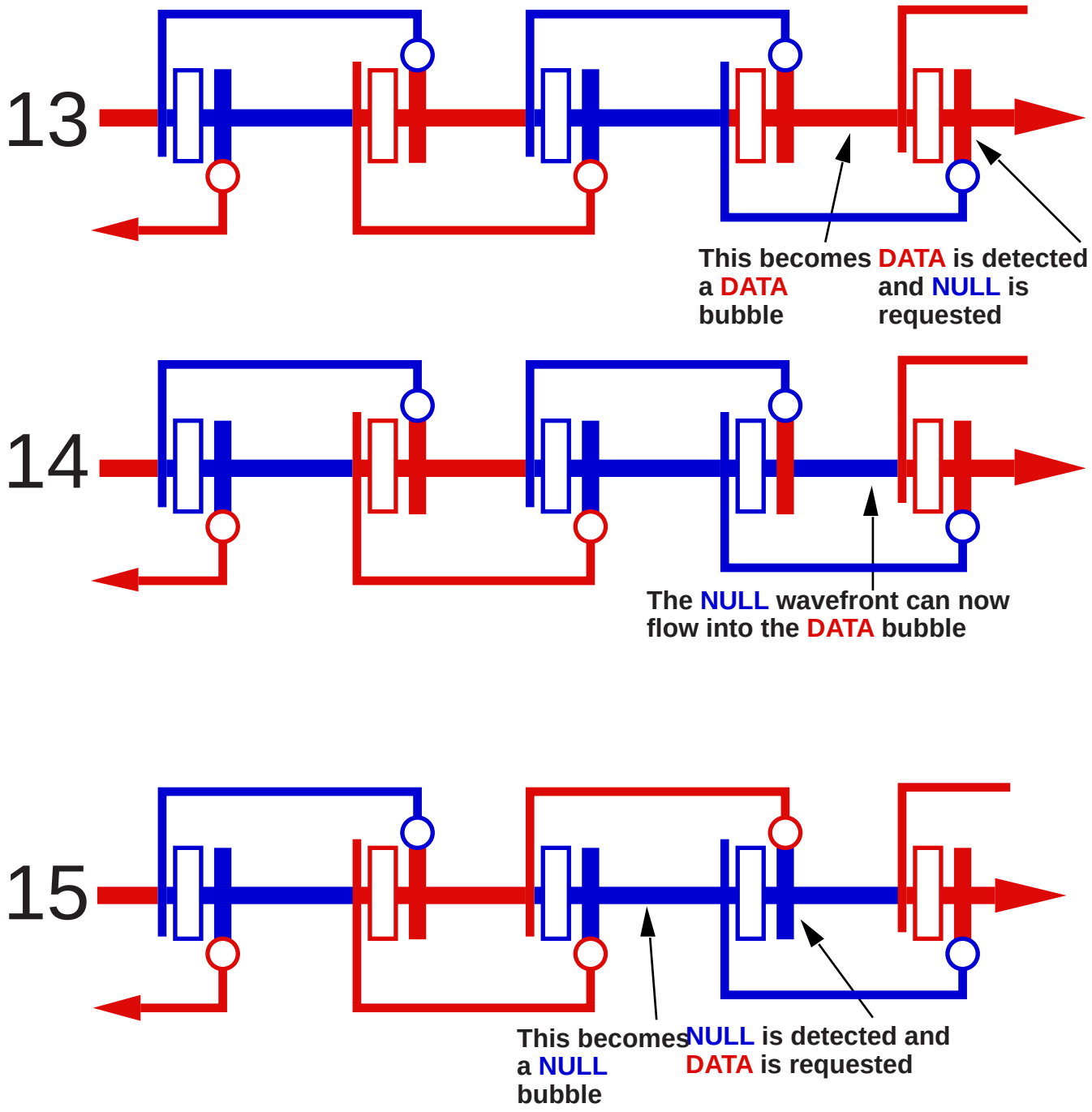
As successive wavefronts arrive the pipeline fills up with stably maintained wavefronts.

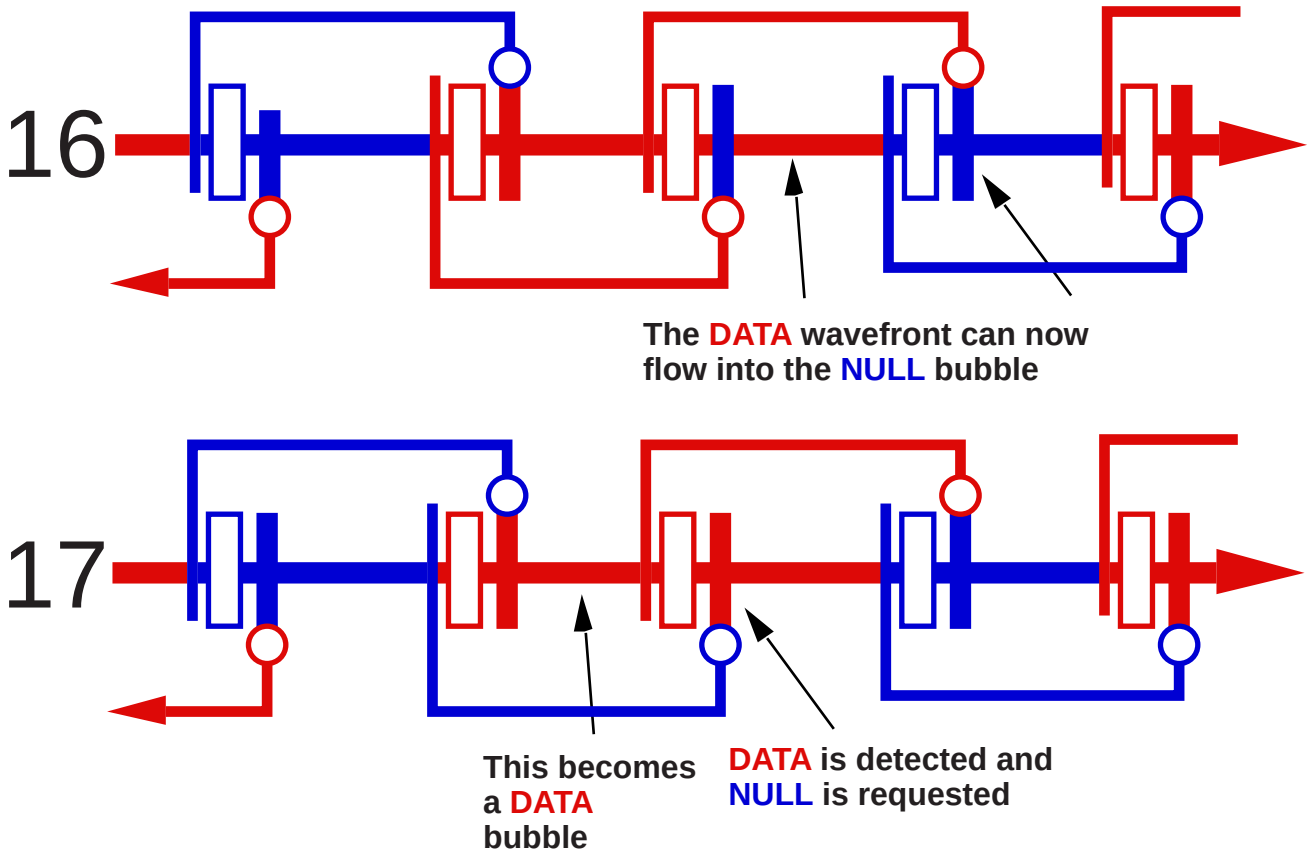


No further propagation will occur until the rightmost Ack requests DATA.






13
This becomes a DATA bubble
DATA is detected and NULL is requested
14
The NULL wavefront can now flow into the DATA bubble
15
This becomes a NULL bubble
NULL is detected and DATA is requested



Wavefronts spontaneously flow forward into bubbles.

Bubbles flow backward through wavefronts.

This spontaneous counterflow of wavefronts and bubbles provides the dynamic behavior of logically determined pipelines.